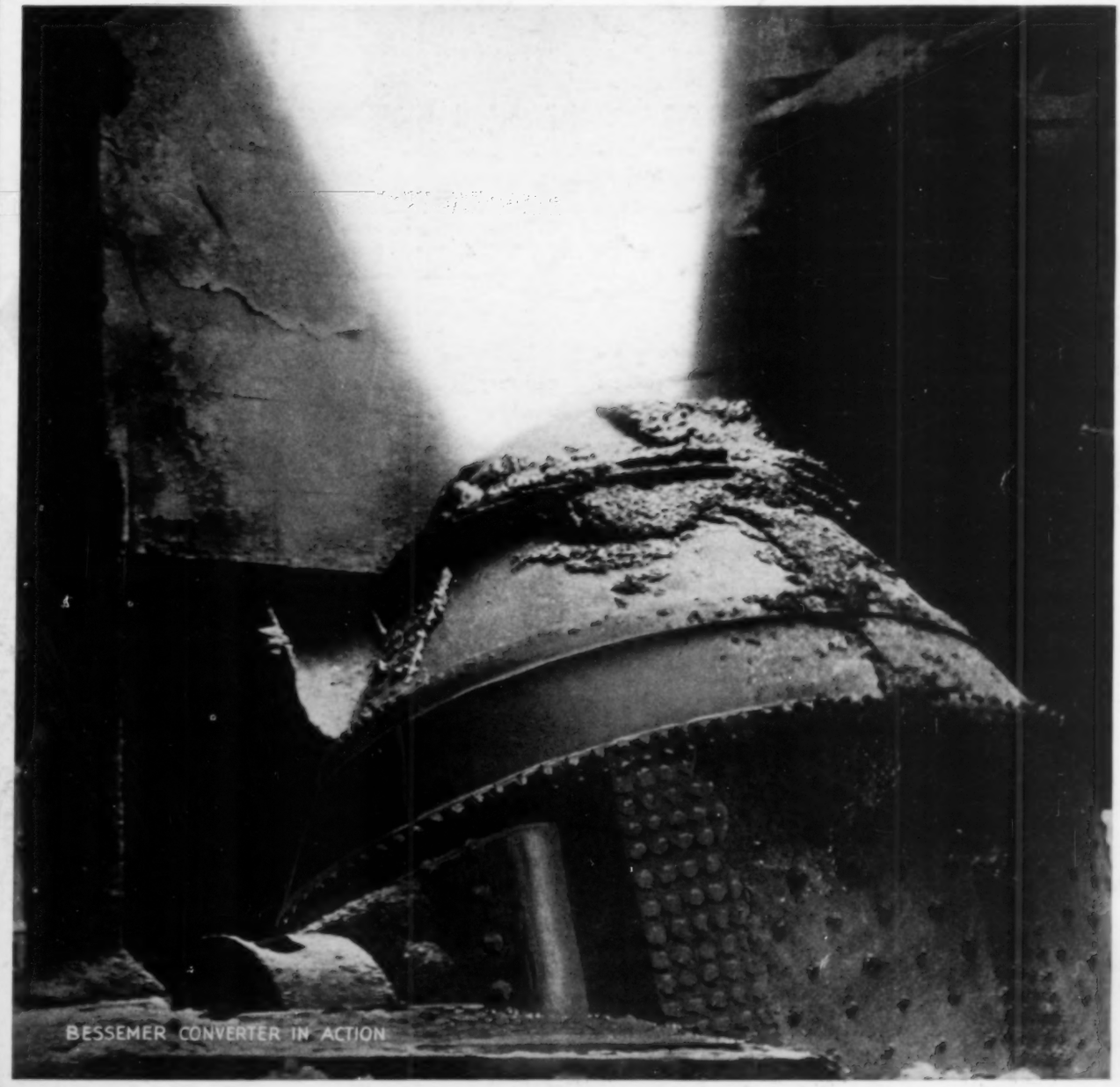
Compressed Air Magazine

VOLUME 46 · NUMBER 8 AUGUST 1941 LONDON · NEW YORK · PARIS



BESSEMER CONVERTER IN ACTION

Speeding Defense Construction
WAUKESHA ENGINES
Help Build Airplane Engine Plant

Waukesha power helps to speed defense construction of this new Buick Aircraft Corporation plant at Chicago. A Waukesha SRKR 100-125 hp. gasoline engine does its bit and drives the Koehring 27E paver, which spreads the concrete for the floor.

All over the country—wherever industrial production facilities are being built, modernized or expanded—Waukesha is on the job. Where army or navy air bases, supply depots, barracks, hospitals, water supply systems, sewers, docks and ship yards are being built, Waukesha Engines power air compressors, lighting generators, crushers, shovels, mixers, pavers, graders . . .

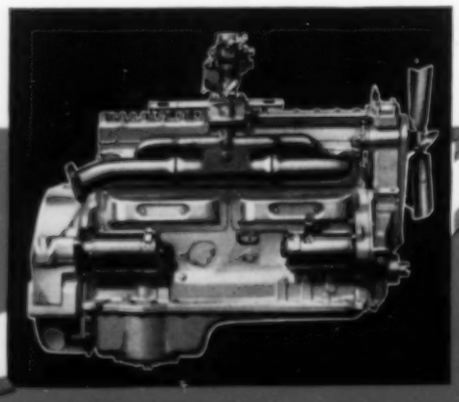
Powering not only contractors' construction machinery, but the machinery that builds the nation's roads . . . powering the trucks that roll along over them carrying equipment, materials and men.

Waukesha Gasoline and Oil Engines for Industrial, Stationary and Automotive Power range in size from 5 hp. to over 300 hp.

Bulletin 1079 is a complete catalog of every Waukesha Engine and Power Unit with ratings, speed torque, horsepower and size. *Send for it today.*

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.

NEW YORK TULSA LOS ANGELES



MORE POWER FOR DEFENSE

WAUKESHA ENGINES

Silent Night!?

IS 24 HR. OPERATION OF COMPRESSORS, DIESELS, ETC., CAUSING COMPLAINTS ?????

Model DS

Are people near your plant complaining of noise at night? If so, and the noise is from the air intake on compressors and internal combustion engines, here's the solution:

PROTECTOMOTOR SILENCER-FILTER FOR ENGINE INTAKE

The Model DS Silencer-filter hushes the most raucous air intake—plus preventing the entry of abrasive foreign matter. The Model DS does double duty—helps prevent complaints due to night operation, saves excess wear on engines and compressors due to intake of abrasive dust. Quickly and easily installed, the Model DS provides capacities and threaded or flanged connections for any engine or compressor.

Always Reduces Engine Wear—
May Prevent a "Nuisance Action"

A. Series of cylindrical rectifying chambers of scientific diameter to length ratio which smooths out sound waves.

B. Dry Feltex Filtering Medium 99.8% efficient by University of California Laboratory tests.

C. Radial Fin Construction. Permits large area of filtering medium to occupy smallest possible space.

D. Rigid, galvanized mesh frame

E. Reinforcing tube. The Model DS Protectomotor is "built like a battleship."

NEW CATALOG

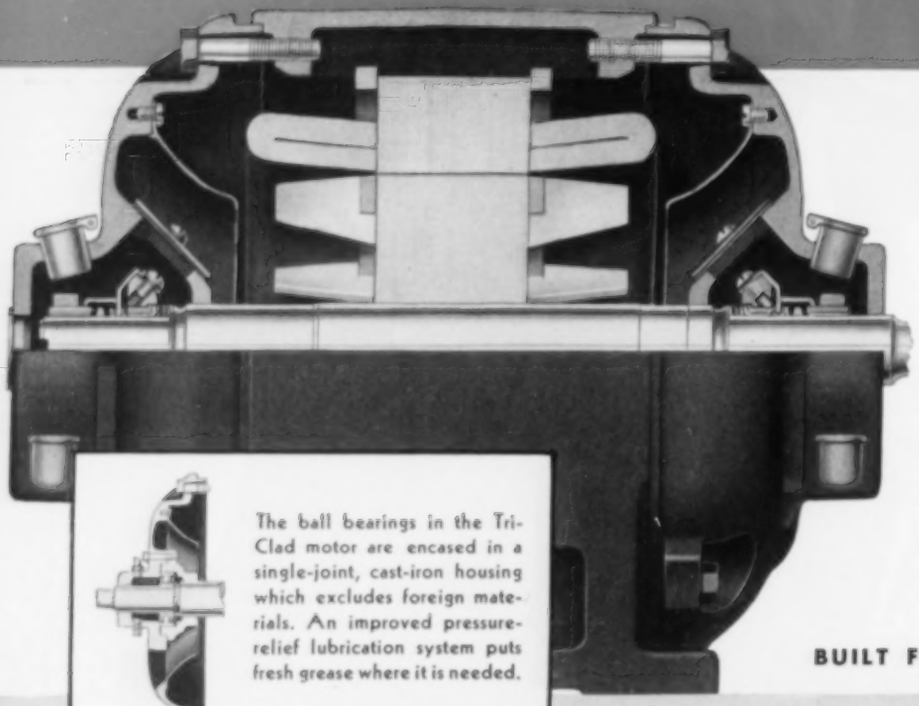
44 pages, completely illustrates and describes filters for ventilation and pipe lines as well as engine intake.

STAYNEW FILTER CORP.
71 LEIGHTON AVE., ROCHESTER, N. Y.
"Air Filter Headquarters"

PROTECTOMOTOR
99 30/100 Per Cent EFFICIENT
AIR FILTERS

We Cut Your MAINTENANCE WORRIES

WHEN WE CUT THE ENDS OFF THE BEARINGS!



The ball bearings in the Tri-Clad motor are encased in a single-joint, cast-iron housing which excludes foreign materials. An improved pressure-relief lubrication system puts fresh grease where it is needed.

In the Tri-Clad motor, G.E. uses a SHORTER sleeve bearing for LONGER life

This *shortened* sleeve bearing has higher load-carrying capacity and longer life. Positive lubrication is assured by its corrosion-resisting oil ring and improved spiral grooving—the bearing runs full of oil regardless of the direction from which the load is imposed.

1 to 20 hp now available.

BUILT FOR PROTECTION FIRST . . . . TO LAST!

TRI CLAD

REG. U.S. PAT. OFF.

INDUCTION MOTORS

GIVE EXTRA PROTECTION 3 WAYS

Extra Protection

AGAINST PHYSICAL DAMAGE

The strong, one-piece, cast-iron frame and end shields, with upper portion completely enclosed, protect vital motor parts from external blows, flying chips, settling dust, and dripping liquids.

Extra Protection

AGAINST ELECTRICAL BREAKDOWN

Stator windings of Formex wire resist moisture, oil, and "heat shock." A tough, synthetic resin bonds the coils, and a coat of Glyptal No. 1201 Red on the end windings completes the insulation.

Extra Protection

AGAINST OPERATING WEAR AND TEAR

For years, G-E motor designers have been experimenting with sleeve bearings of all kinds. They have found that a shorter sleeve bearing—one with new diameter-to-length proportions and a more effective spiral grooving—is a fundamentally better bearing; that such a bearing could successfully withstand the stress imposed by short-center, hinged-base drives and similar applications.

In addition, the new sleeve-bearing housing on Tri-Clad motors is dust- and oil-tight. These and many other features are your assurance of a dependable, free-running motor.

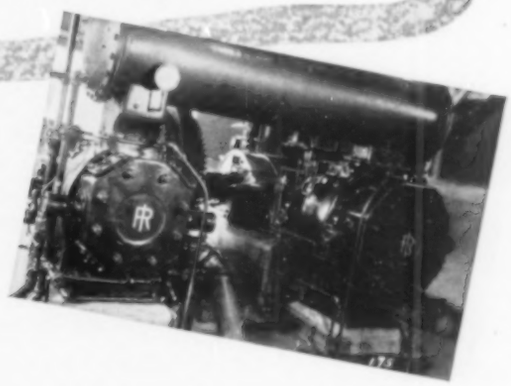
You'll find that Tri-Clad motors are unusually quiet and smooth running. They'll give your production *extra protection* during *extra* years of service. General Electric Co., Schenectady, N. Y.

Write for Bulletin GEA-3580 and specify Tri-Clad on your next motor order.

GENERAL ELECTRIC

HAVE YOU HEARD ABOUT MY OPERATION?

"IT'S PERFECT! I am a valve from this big I-R Compressor. I've never been more active in my life . . . never known such freedom from carbon trouble."



INGERSOLL-RAND PRE 12½x-20x14, 2-stage Compressor operating almost continuously since 1928. Not once has a spare valve been taken out of stock. Nor has a ring stuck, nor hard carbon accumulated. Lubricant...*TEXACO ALGOL OIL*, exclusively.

THE LUBRICANTS that are keeping this and thousands of other compressor valves on the job . . . clean . . . opening wide and shutting tight . . . are TEXACO.

Texaco Alcaid, Algol and Ursa Oils are highly stable, resist gumming, sludging and the formation of carbon deposits. They assure more efficient valve action and much longer service between inspections and cleanings.

The outstanding performance that has made Texaco preferred in the fields listed in the panel has made it preferred also by some of the largest compressor operators in the United States.

These Texaco users enjoy many benefits that can also be yours. A Texaco Lubrication Engineer will gladly cooperate . . . just phone the nearest of more than 2300 Texaco distributing plants in the 48 States, or write:

The Texas Company, 135 E. 42nd Street, New York, N. Y.

TUNE IN: "Treasury Hour—Millions for Defense," All-Star Radio Program. Every Wednesday Night, CBS. 9:00 E.D.T., 8:00 E.S.T.; 8:00 C.D.T., 7:00 C.S.T.; 6:00 M.S.T.; 5:00 P.S.T.

ROCK DRILLS—a 36-page booklet of pictures and text to help you keep your rock drills on the job. Yours for the asking.

THEY PREFER TEXACO

★ More locomotives and cars in the U. S. are lubricated with Texaco than with any other brand.

★ More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

★ More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

TEXACO

TEXACO Lubricants

FOR ALL COMPRESSORS AND AIR TOOLS

BOILER PRESSURES *Are Going Up!*

With modern stations using constantly higher boiler pressures, the construction of the boiler-feed pump becomes increasingly important. Ingersoll-Rand has unexcelled facilities and experience for building all types of boiler-feed pumps.

Outstanding Metallurgical Facilities—Materials used in boiler-feed pumps largely determine their life. Ingersoll-Rand has outstanding metallurgical facilities, heat treating plants and long experience in building boiler-feed pumps and other machines requiring specially treated metals.

A Modern Plant — Quality boiler-feed pumps require manufacturing experience, technique and equipment not available a few years ago. Such facilities are available today in the Ingersoll-Rand plant.

Ability to Fit the Pump to the Job—Every boiler plant requires feed pumps exactly suited to its needs. Ingersoll-Rand has the years of experience required to build pumps to meet successfully all the varying factors encountered.

A Successful Record—The record of Ingersoll-Rand pumps over a long period of time is one unmatched for reliability and efficiency. Ingersoll-Rand built its first multi-stage pump in 1915 for 175 lb. pressure. In 1940 they built pumps to deliver 2800 lb. pressure for the highest pressure plant in the country.

Unexcelled Test Facilities—The facilities for testing Ingersoll-Rand pumps excell those of other pump manufacturers. Exact performance at field conditions is accurately predetermined before the pump is shipped.

5" 7-stage boiler type pump for 2000 lb. pressure.

Ingersoll-Rand

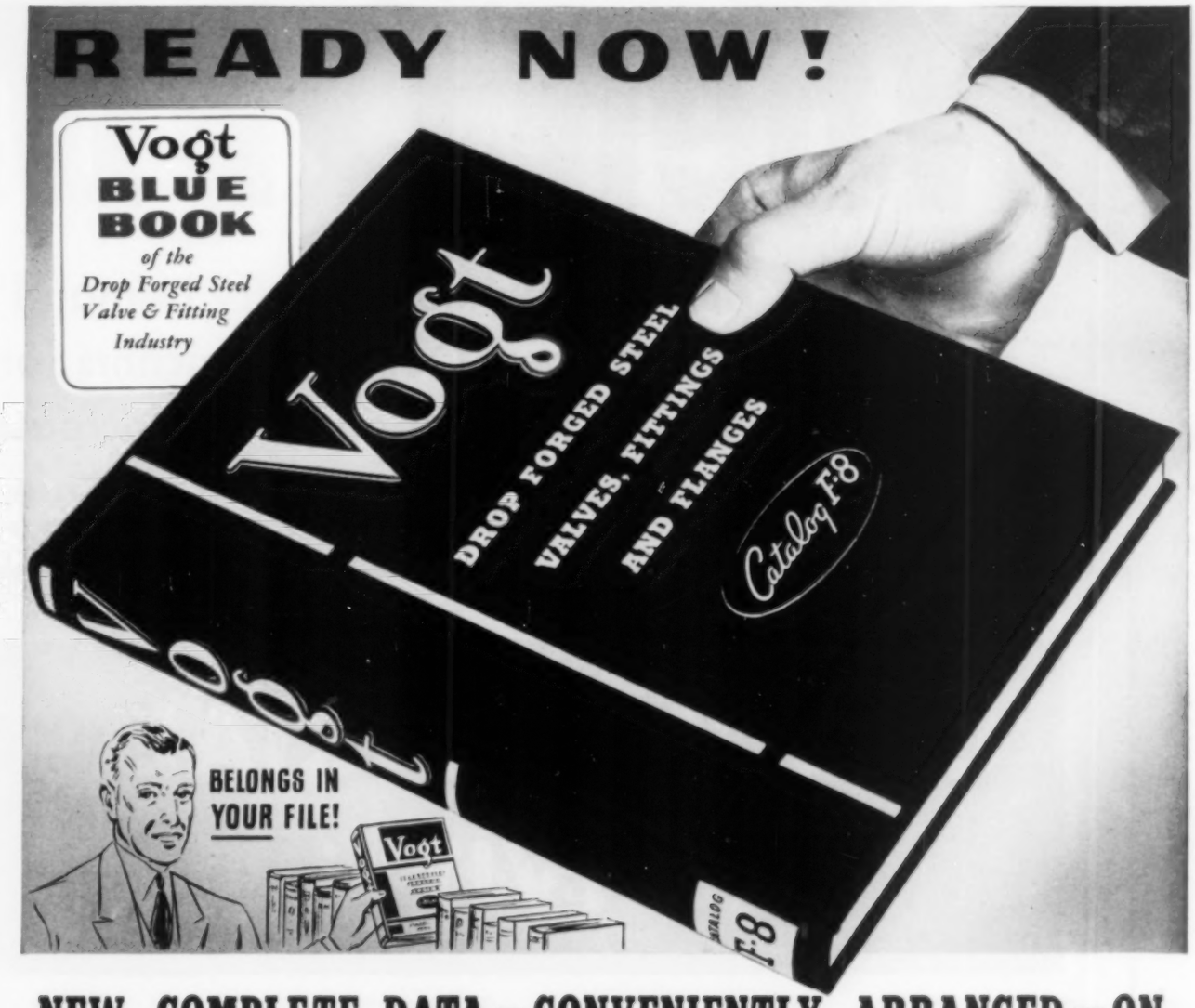
Cameron Pump Division

10-10 11 BROADWAY NEW YORK, N. Y.

Atlanta	Buffalo	Cincinnati	Denver	El Paso	Kansas City	Newark	Philadelphia	Pottsville	Scranton	St. Paul
Birmingham	Butte	Cleveland	Detroit	Hartford	Knoxville	New Orleans	Picher	Salt Lake City	Seattle	Tulsa
Boston	Chicago	Dallas	Duluth	Houston	Los Angeles	New York	Pittsburgh	San Francisco	St. Louis	Washington

READY NOW!

Vogt BLUE BOOK *of the Drop Forged Steel Valve & Fitting Industry*



NEW COMPLETE DATA – CONVENIENTLY ARRANGED – ON VOGT DROP FORGED STEEL VALVES, FITTINGS AND FLANGES!

This new 328 page volume of informative data on Vogt *drop forged steel* Valves, Fittings and Flanges is ready to serve you. Use it for up to the minute information on the most comprehensive line of drop forged steel piping materials *anywhere available* to industries requiring safe and efficient handling of oil, steam, water, air, gas, and ammonia, at high or low pressures and temperatures, in process work.

A request on your company letterhead will receive prompt attention!

HENRY VOGT MACHINE CO., Inc.
LOUISVILLE, KENTUCKY

Branch Offices: New York, Philadelphia, Cleveland, Chicago, Cincinnati, St. Louis, Dallas.

Vogt

When OPM

Production Men Throughout Industry Demand and Rely on the Highest Quality Lubricants for Their Machines. The Tremendous Sales Increase of Gargoyle Lubricants Proves This to be True.

U. S. INDUSTRIAL ACTIVITY*

SALES OF GARGOYLE

CALL IN Socony-Vacuum for

Says "RUSH"

INDUSTRY'S MARCHING ORDERS are "double-quick"! Machine replacements and parts are hard to get. So, to assure continuous, high-speed production, operating men agree on this point:

Today—there can be no compromise with the quality of industrial lubrication!

When men in industry take this position, what brand do they turn to? *They turn to Gargoyle Lubricants!* The record speaks for itself!

And that record gives you an answer to *your* No. 1 problem. Protect *your* production with the world's No. 1 line of industrial lubricants—Gargoyle Oils and Greases.

• • •

SOCONY-VACUUM OIL COMPANY, INC. · Standard Oil of New York Div. · White Star Div. · Lubrite Div. · Chicago Div. White Eagle Div. · Wadhams Div. · Southeastern Div. (Baltimore) · Magnolia Petroleum Co. · General Petroleum Corporation of California.

LOOK AT THE RECORD. IN TIMES LIKE THESE, INDUSTRY DEMANDS QUALITY. LET THIS CHART BE YOUR GUIDE, TOO

Chart shows percent of Gargoyle Lubricants sales increase compared to U.S. Industrial Activity—May, 1940-May, 1941

LUBRICANTS

GARGOYLE Lubricants

*SOURCE—Business Week Index of Industrial Activity.

"Correct Lubrication"

"A RECORD FOR CONSTANT OPERATION"

Trouble-free turbine means trouble-free operation for prominent fuel company.

A case history showing the trouble-free service you can expect wherever you see the Coppus **BLUE RIBBON**

"This turbine pump has performed 24 hours a day for more than three years and has never been shut down . . . is still operating 24 hours a day, and we have never had any maintenance cost of any kind on either turbine or pump. This is a record for continuous operation for any piece of machinery we have ever installed."

To insure consistently dependable operation of turbine-powered equipment, write "Coppus" on your specification. The "blue ribbon" painted on the flange indicates:

1. **PRECISION WORKMANSHIP**—controlled by Johansson size blocks.
2. **ENCASED GOVERNOR**—slow speed, leverless.
3. **SEPARATE SAFETY TRIP**—pilot-operated, leverless.
4. **PARTIAL LOAD ECONOMY**—by individual nozzle control.
5. **DYNAMOMETER TESTED**—before shipment.

During 1940, 87% of orders for Coppus Steam Turbines were repeat orders. Bulletin 135-9 describes vertical and horizontal types; also with built-in speed reducer. Steam, air or gas-operated. Write for this bulletin today.

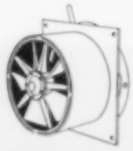
H. P. not E. P.* for small H. P. jobs.

*Elephant Power—a large-size turbine for a job a small-size Coppus could handle. Save investment cost with a Coppus Turbine sized close to your needs.

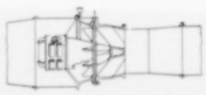
COPPUS ENGINEERING CORP., 227 Park Ave., Worcester, Mass. Sales offices in THOMAS' REGISTER. See SWEET'S CATLOG for other "Blue Ribbon" products—air filters, gas burners, blowers, ventilators, fans.

COPPUS BLUE RIBBON PRODUCTS

Designed for your Industry
Engineered for You

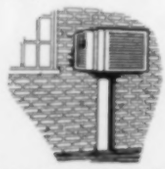


COPPUS-DENNIS FANMIX GAS BURNER. New method of mixing gas and air insures perfect gas-air ratio—instant, complete combustion. Bulletin 410-2.



COPPUS VANO BLOWERS. 1001 uses. High efficiency on special installations where ordinary fans fail. Bulletin 115-6.

COPPUS CABLE MANHOLE AND TANK VENTILATORS. For any confined working space. Special adaptions for boilers, tank cars, shipholds. Bulletin 163-1



COPPUS AIR FILTERS. For engines and air compressors. Perfect, uninterrupted filtration. Bulletin F-310-4.

COPPUS

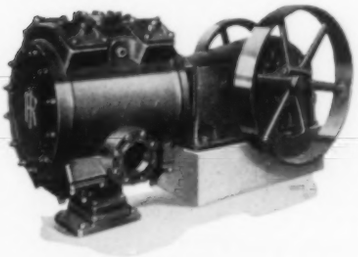
VACUUM EQUIPMENT

For the Process Industries

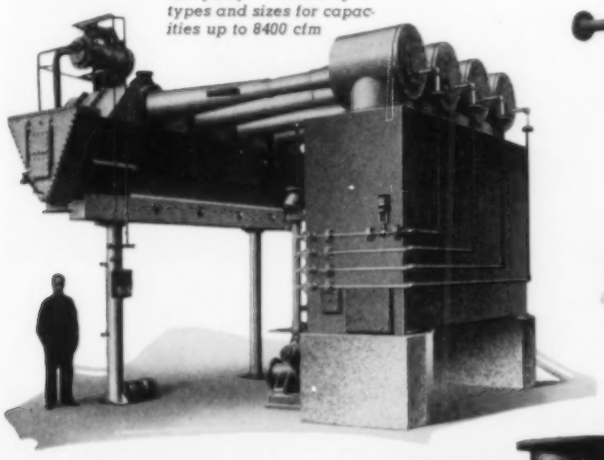
If you have a vacuum producing problem, you will find the Ingersoll-Rand line of equipment and the long experience of its engineers invaluable to you. You can select from a complete range of sizes in steam-jet ejectors, surface and barometric type condensers, reciprocating dry-vacuum pumps and steam-jet refrigerating units, and auxiliaries such as centrifugal pumps.

Vacuum equipment must be fitted precisely to the job. Our engineers can recommend the proper type of equipment or combination of types for any vacuum service. They are in a position to do this because of the company's wide experience in vacuum and condenser problems, its well equipped laboratory, its policy of continuous research, its mass of test data for designing purposes and its modern manufacturing methods and facilities.

Ask our nearest office for recommendations. We will gladly help you.

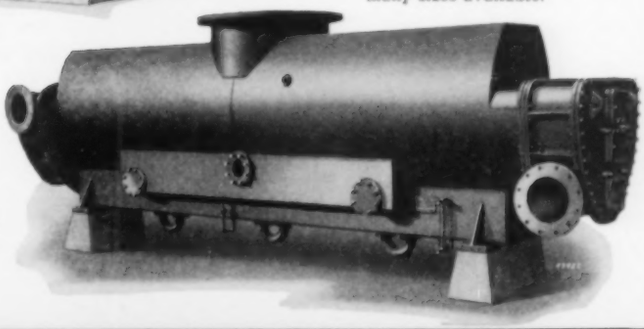


Reciprocating, dry-vacuum pump — A variety of types and sizes for capacities up to 8400 cfm

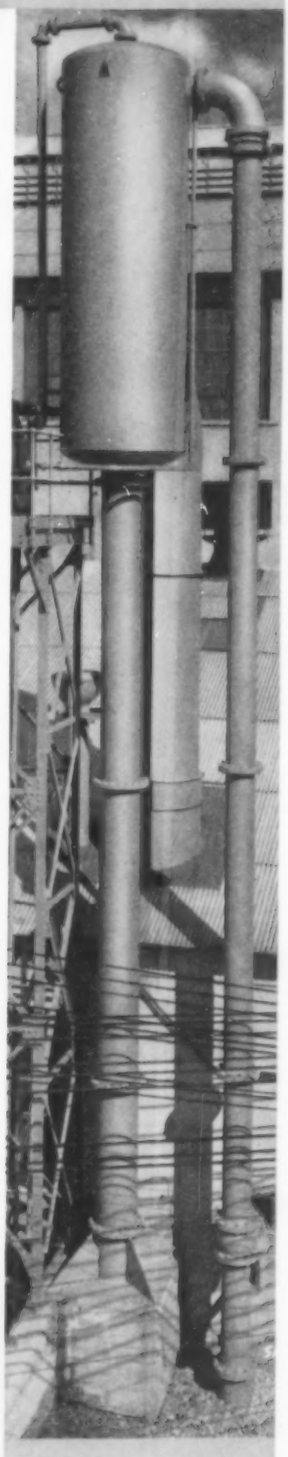


A single-stage, multi-element, steam-jet ejector — One of the many sizes available.

Steam-jet refrigeration unit — available in sizes from 10 to 600 tons of refrigeration.



Surface condenser — sizes available to serve prime movers up to 160,000 kw. capacity.



Barometric-type condenser — A complete range of sizes.

Atlanta
Birmingham
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Cleveland
Dallas
Denver
Detroit
Duluth
El Paso
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Ingersoll-Rand

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San Francisco
Scranton
Seattle
St. Louis
St. Paul
Tulsa
Washington

4-56

2 THINGS TO KNOW ABOUT DETACHABLE BITS

1 WHAT THEIR ADVANTAGES ARE

More and more people are switching to detachable bits. The chances are you, too, will want to make the change when you examine this list of advantages:

1 *They reduce steel-shop costs.*
2 *Nipping charges are reduced.*
3 *They eliminate the necessity of carrying steel in and out of working places, which permits more time for drilling.*
4 *Bits drill faster than ordinary steel drills.*
5 *Bits are safe in use in stopes and raises.*
6 *Rod lengths and bits can be standardized.*
7 *Bits work well in muddy or soft ground.*

2 HOW TO KEEP THEM IN CONDITION

The secret of realizing all the advantages of detachable bits is in keeping them properly ground. For best results... for lowest cost per grind and the most work from each resharpened bit... you've got to use the *right* grinding wheels for forming and gauging.

One way to be sure of getting the right wheel is to specify Aloxite Brand Aluminum Oxide Wheels. These long-lived wheels are especially made by Carborundum to hold their shape, and to cut fast, free and cool. They assure you accurate gauge and form... longer tool life between grinds... reduced grinding time... and lower cost per grind.

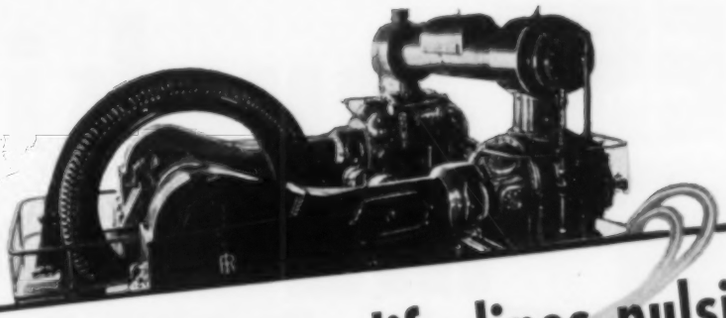
CARBORUNDUM
ABRASIVE PRODUCTS

Remember the name "Aloxite Brand" when you order.

THE CARBORUNDUM COMPANY • **NIAGARA FALLS, N.Y.**

Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh, Cincinnati, Grand Rapids

(Carborundum and Aloxite are registered trade-marks of and indicate manufacture by The Carborundum Company)



Keep production life lines pulsing with stable SHELL COMPRESSA OIL

The order of the day is full speed ahead and no time out for compressor shutdowns. That's why scores of mine owners and operators have turned to Shell Compressa Oil for the answer to dependable compressor operation. Shell Compressa Oil—

1—Is highly stable under the most severe operating conditions.

2—Prevents excessive formation of hard carbon deposits . . . does not break down at high compression temperatures. Retains its lubrication qualities.

3—Keeps discharge valves working freely . . . helps prevent ring sticking and blow-by.

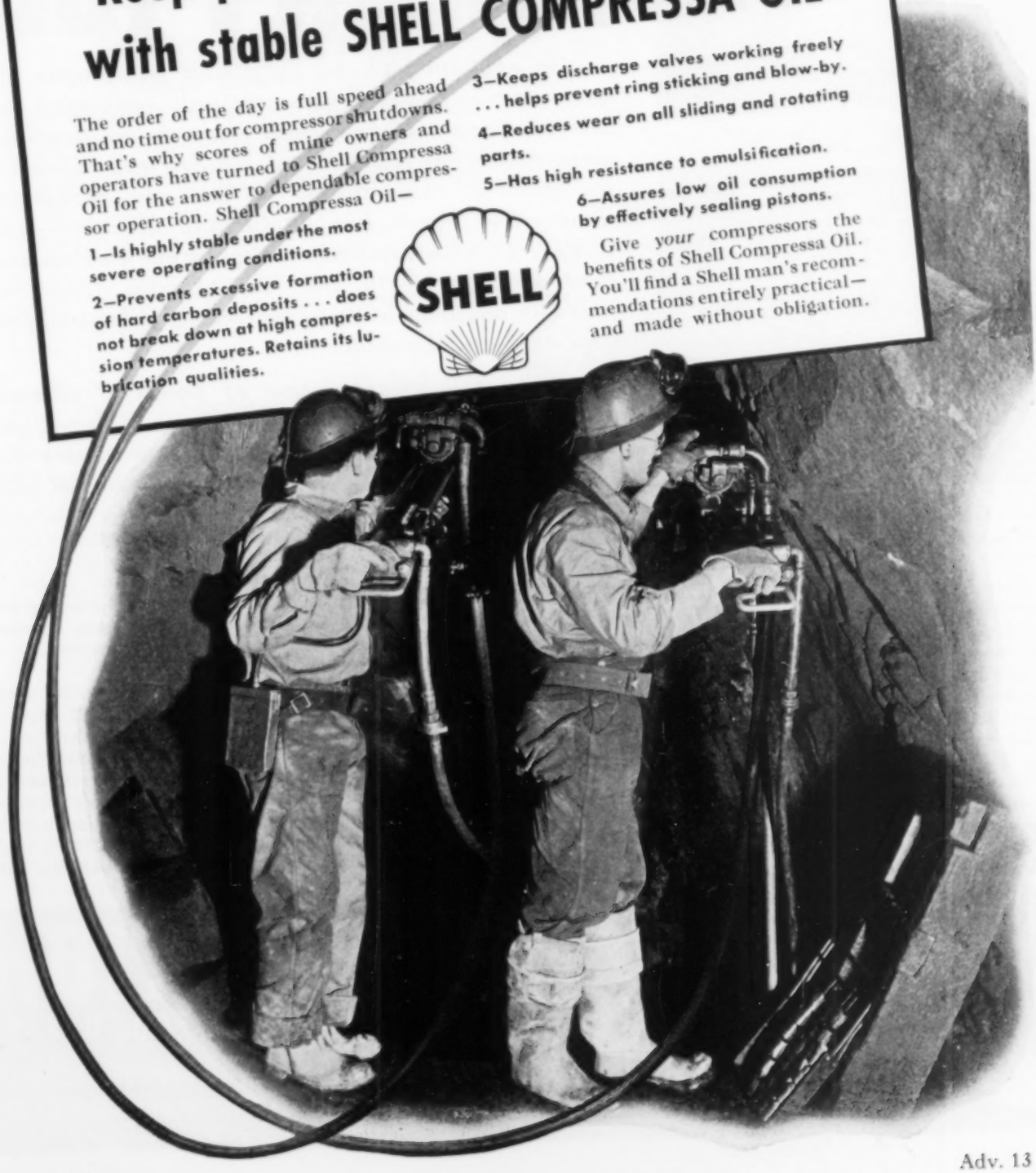
4—Reduces wear on all sliding and rotating parts.

5—Has high resistance to emulsification.

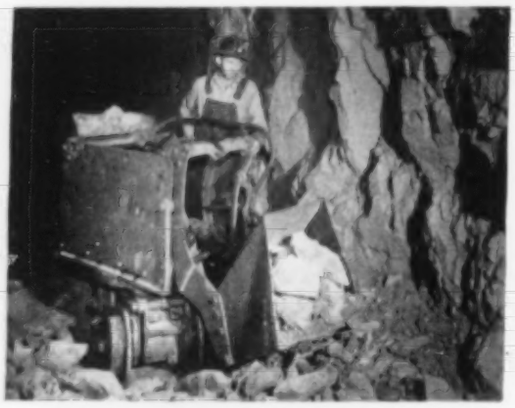
6—Assures low oil consumption by effectively sealing pistons.

Give *your* compressors the benefits of Shell Compressa Oil. You'll find a Shell man's recommendations entirely practical—and made without obligation.

SHELL



the BEST mucking machine for ANY job



Model 12-B

Model 21

As explained in the following paragraphs we have, during the past year, not only continued the ten-year program of constant research and development which has always kept Eimco-Finlay Loaders far ahead of competition, but have also developed a new and much larger mucking machine—the EIMCO TUNNELOADER—with ample loading and clean-up capacity to meet the heaviest demands; and with obvious ability to completely fill the largest cars used underground.

From this enlarged line of powerful all-steel loaders—all using the patented Eimco-Finlay Rocker-Arm Mucking Action—you can now secure the best mucking machine for ANY job, at lowest ultimate expense.

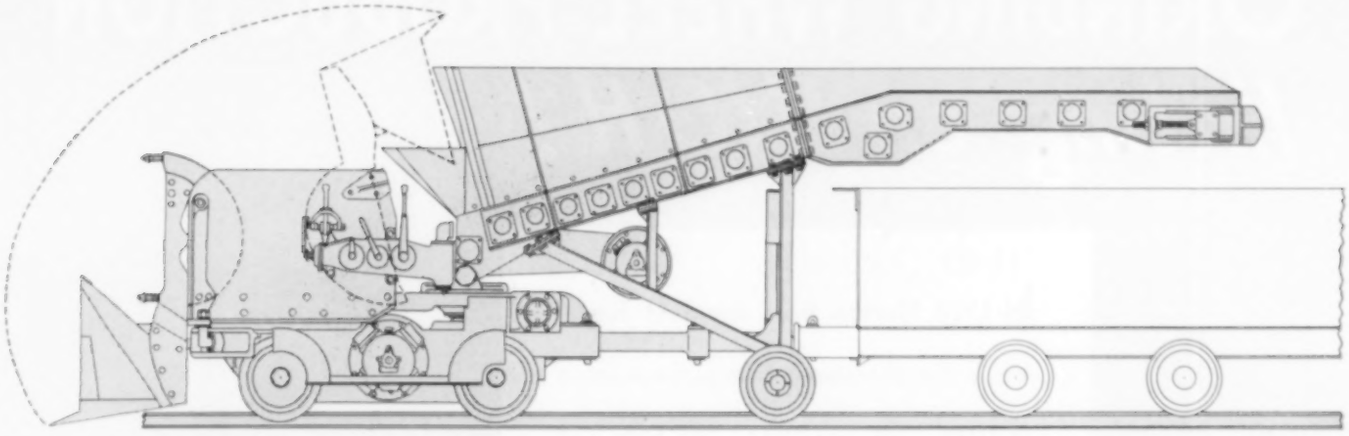
EIMCO-FINLAY LOADERS

Already out-performing any other mucking machines of comparable size and type the Model 12-B and Model 21 Eimco-Finlay Loaders have recently been raised to still greater heights of superiority by the introduction of a new high-torque, high-power, five-cylinder radial air motor, designed especially for this purpose by the Ingersoll-Rand Company and containing many improved features never before available. The combination of this new high-power motor with our patented, exclusive, rocker-arm mucking action, gives astonishing speed, power and flexibility. When digging into a muck pile both crowding force and digging thrust are so great that stalling is almost impossible. After the bucket has been filled the elevating acceleration is so rapid (if desired) that even larger cars can be filled than heretofore. Tramming speeds, in either direction, can also be made much faster.

The Model 12-B Eimco-Finlay Loader can be used effectively in drifts as small as 4'-6" wide by 6' high—loads cars up to 50 cu. ft. capacity at the rate of a ton per minute—uses less air than the average "drifter" drilling machine. Model 21, with wider clean-up, loads larger cars at the rate of two tons per minute. Either machine, if used to anywhere near capacity, will save its entire cost in less than 600 ft. of drifting and still be practically as good as new. Bulletin No. 105 (48 pages) gives complete information.

The EIMCO CORPORATION
SALT LAKE CITY, UTAH, U.S.A.

NEW YORK, 120 Broadway — SACRAMENTO, 1217 7th St.
CHICAGO, 111 W. Washington Ave. — EL PASO, Mills Building

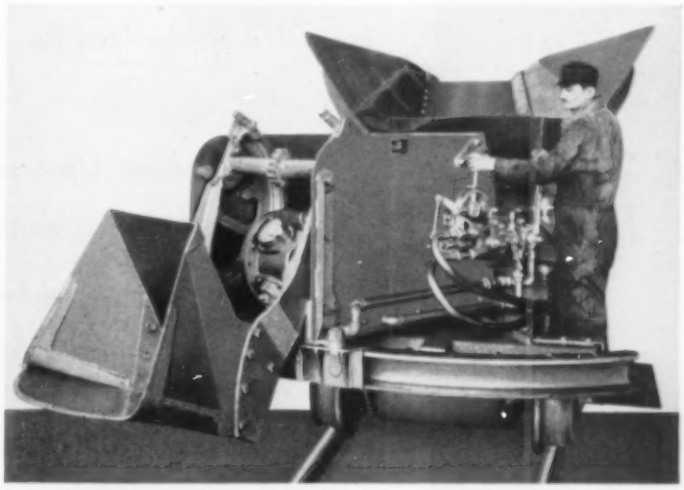


THE EIMCO MODEL 40 Tunneloader

The unequalled efficiency and economy of our Eimco-Finlay Mine-Car Loaders have naturally brought many requests from tunnel contractors for a mucking machine operating on the same fundamental principle, but having greater digging capacity, wider clean-up and ability to fill longer cars.

In the Eimco Tunneloader we now offer a machine which not only meets all of these specifications 100%, but also affords the additional important advantage of being powered by either compressed air or electric motors as desired. In either case its operation is almost unbelievably efficient—crowding the 12 cu. ft. bucket deep into any muck pile by its enormous self-tramming power—rolling the heaviest bucket load easily and swiftly over into its dumping position—pouring such a stream of muck off the end of its 28" conveyor that the largest cars are filled completely full at the rate of more than three tons per minute.

Besides being much larger and more powerful than any of our previous loading machines, it is equipped with a separately-powered self-locking worm-and-gear mechanism for swinging the bucket assembly to any desired digging position without manual effort by the operator. Another improved feature is the large hopper into which the bucket discharges direct from any digging position, and from which the muck is continually carried away by the belt conveyor.



Other important operating advantages include sectionalized construction, which permits traveling around relatively sharp curves—easy disassembling for transportation or caging—surprisingly moderate head-room requirements, and very low expense for both operation and maintenance. Write for bulletin 106 or use the convenient coupon below.

OUR GUARANTEE

Year after year, far more Eimco-Finlay Loaders are manufactured and sold than all competitive types combined, and their inherent superiority has been so thoroughly established that every Model 12-B or Model 21 machine is sold with a positive, money-back guarantee that it will outlast and outperform any other mucking machine on the market of comparable size and type, at any air pressure and under any working conditions.

We now guarantee the Eimco Tunneloader to outperform ANY other type of underground mucking machine—regardless of size or price.

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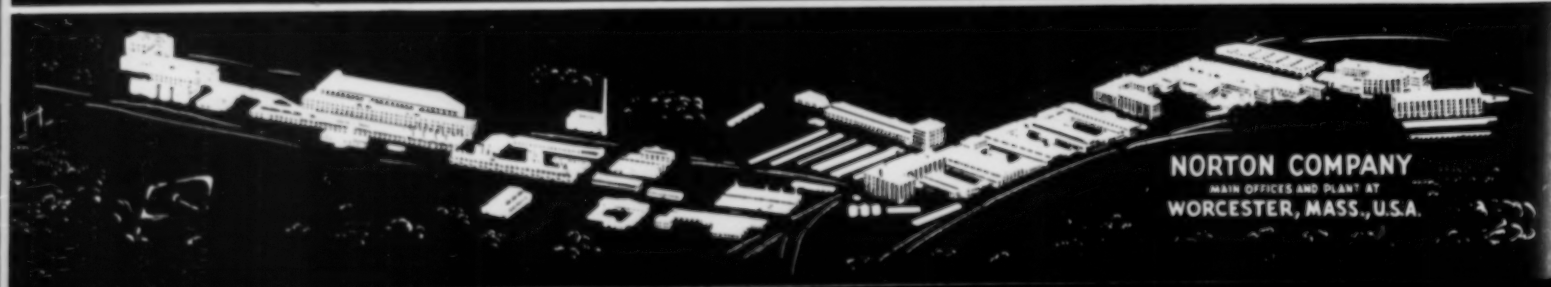

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ON THE COVER

OUR cover picture shows a Bessemer converter at close range and at the height of a blow. It reveals details of the exterior construction of the vessel, which is one of the earliest pieces of equipment used in modern times for making steel. Compressed air enters importantly into the Bessemer process.

•

IN THIS ISSUE

AS A PART of the National Defense effort, the nation's steel companies have been asked to increase their capacity by 10 per cent. This involves utilizing more scrap iron and also the production of more pig iron. Part of the latter will be made into steel in Bessemer converters, once dominant in the industry but relegated sometime ago to comparative obscurity by open hearth and electric furnaces. Lately, however, technological advances in methods of control have pointed the way to better Bessemer steel, and, fortunately, there are available many unused vessels that can be quickly restored to service. Our leading article traces the history of the iron and steel industry and injects some thoughts on a few of the many things that can be done to improve the pneumatic phase of the Bessemer process.

•

A MINING engineer turned his talents to experimenting with seed grains and, much to his surprise, discovered a way to peel the outer skin from wheat berries. A large baking company is now making a new kind of nature-vitaminized bread as a result. Details of how all this happened are contained in the article, *Flotation Gives Us a New Bread*, beginning on page 6506.

•

THE Missouri River is America's longest stream, but its transportation potentialities have been exploited but little. During the past year, U.S. Army Engineers in the Kansas City District have improved navigation for a distance of 200 miles in its lower reaches, and this work presages greater use of the river for shipping heavy freight. The channel-deepening program involved the drilling and dredging of rock; and as the district had never carried out any large-scale subaqueous rock-removal operations, it was necessary to fit out a drill boat. The vessel and the use made of it are described in our third article.

Compressed Air Magazine

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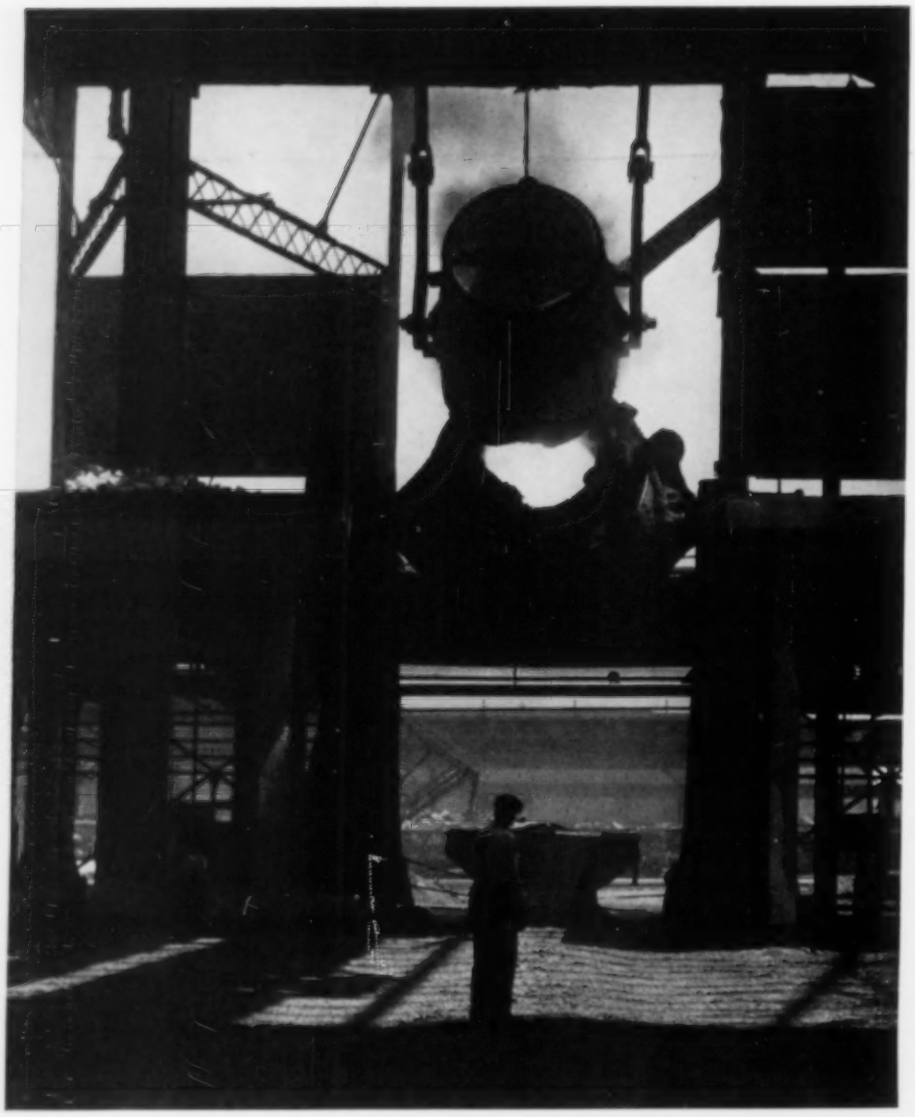


CHARGING

ARCHAEOLOGICAL research indicates that iron has been in use for about 4,000 years, and there is the possibility that it was known and utilized by the Egyptians in building the Pyramids as early as 4000 B. C. The term "iron" as applied here means a material roughly corresponding to "wrought iron." It was soft and malleable and impregnated with slag from its original reduction. Probably the first wrought iron was made on a hearth where charcoal was burned in contact with the ore until a small pasty mass was formed. This was removed and worked or wrought into wrought iron. If reworked to remove more of the slag its physical strength was increased; but as it contained little carbon it was soft and would not keep an edge. In 1880 more than 2,300,000 tons of wrought iron was produced in the United States, against 1,200,000 tons of steel made by all processes. By 1937 the totals were 3,500,000 and 50,000,000 tons, respectively.

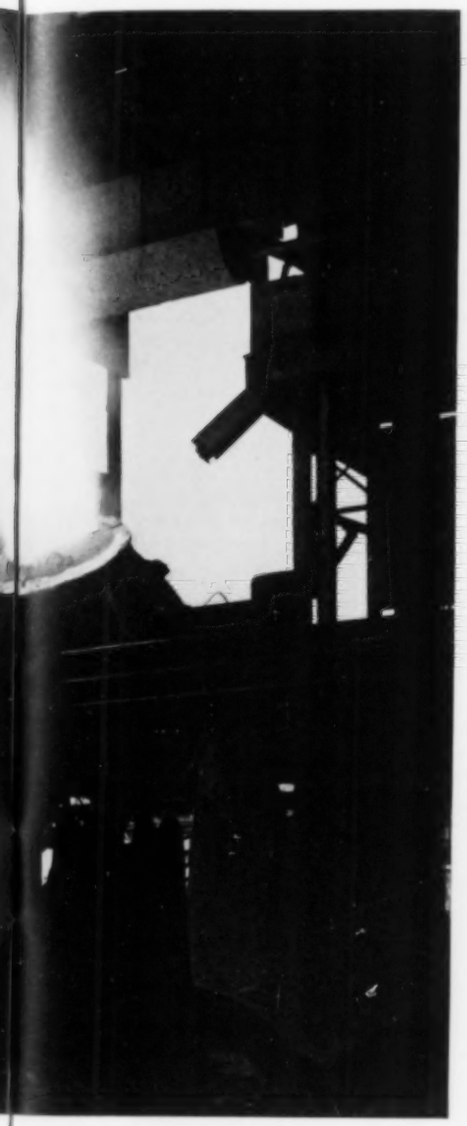
While mechanical improvements in the entire process from ore to finished bar were brought about, there was little change in the metallurgy until about 1100 A.D., when a method to increase the percentage of carbon was developed at several widely separated locations. This increase in carbon after the wrought bar had been made turned the latter into steel.

The steels of Damascus and Toledo were probably made by the crucible method. Selected bars of wrought iron were cut into small pieces and placed with charcoal into a crucible having a tight lid. This was put in a fire and the metal fused. The slag was skimmed off and the metal poured into a mold, where it was allowed to cool. The ingot, now free of slag and dirt, was reheated and worked to its finished form. This process was lost during the Dark Ages and not rediscovered until 1742 by Benjamin Huntsman in England. It was the principal source of high-quality steel until the electric furnace was developed commercially in 1904. In 1910, about 110,000 tons of crucible steel and 50,000 tons of electric steel were made in the United States. By 1937 the outputs had changed to 1,000 tons and 800,000 tons, respectively.

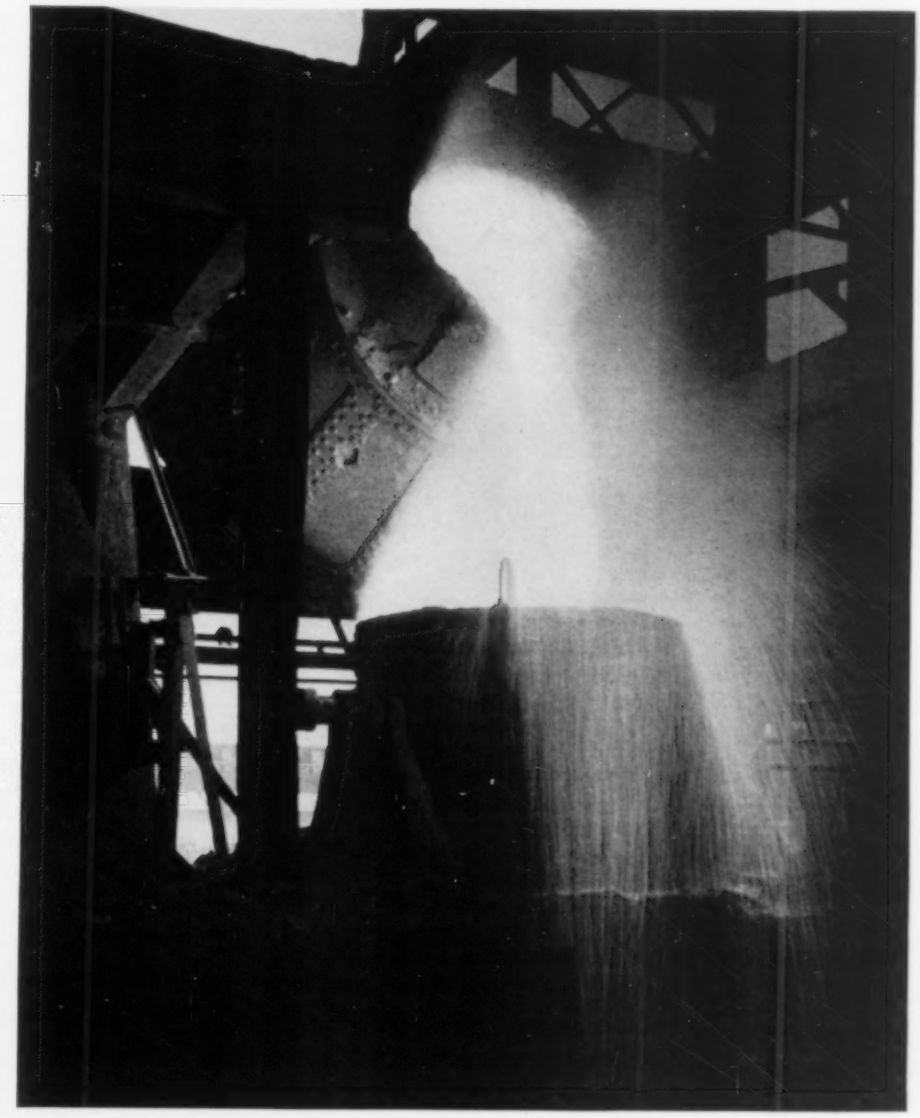
The derivations of the terms used in the iron industry are interesting. The word ingot is the past participle of an Anglo-Saxon verb meaning "poured in," and evidently served to distinguish the metal in that form from the bloom taken from the forge or puddling furnace. The term forge originated from the shop where wrought iron was produced. The puddling furnace was where wrought iron was made by stirring or "rabbling" the material on the hearth. When the bloom was worked into bars they became billets. So now, when an ingot is run through a

Converters

J. S. Fulton



BLOWING



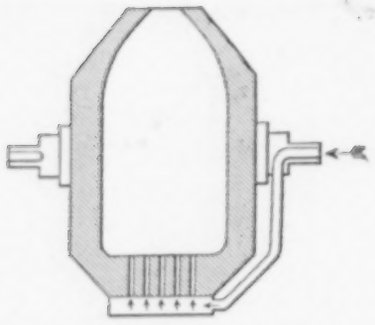
POURING

blooming mill, it comes out in billets or slabs. The reason for the expression "pig iron" is that the old furnaces discharged their metal through a long trough on to a sand casting bed. At right angles to the trough were laterals called "sows," and at right angles to them were the "pigs" they fed.

Both wrought-iron and steel making are much older than is the manufacture of pig iron. According to one writer, the unfortunate artisan who "burned" his charge by allowing it to melt and so to pick up the 3 or 4 per cent of carbon that threw it into the pig or cast-iron category was summarily dealt with. It was not until the middle of the fourteenth century that ironmakers in Central Europe succeeded in producing molten iron that could be cast. This was done in a crude, masonry stack furnace similar to a lime kiln; and a furnace that consistently turned out 5 tons of iron per day created just as much furore as do the monsters of today that produce 1,200 tons.

There was little change in steel making until the 1850's, when the open-hearth and the Bessemer processes were both developed. William Siemens invented a furnace of the regenerative type in which the products of combustion passed through chambers on their way to the stack and left heat in brick checkerwork. The process was reversible, and upon reversal the incoming air and, later, the gaseous fuel were preheated in separate compartments before combustion on the hearth. This considerably increased the furnace temperature. The first regenerative furnace built in 1858 encountered many difficulties, and it was not until 1861, when the fuel was gasified outside the furnace, that the process became a commercial success.

The first furnace was used for making glass. When applied to steel making it only melted down scrap rails, plate, etc. Siemens developed a practice in 1868 by which pig iron replaced the scrap and iron ore was added to oxidize the carbon and thus to make steel. The Martin brothers altered Siemens's process by substituting scrap for the ore and in such an amount that little oxidation was necessary. Present-day open-hearth practice is a combination of these two methods. In steel plants, the molten metal from the blast furnace takes the place of the pig iron. The principal difference, outside of mechanical and ceramic improvements, is in the size of the heats. Siemens's furnace produced 4 tons, whereas present furnaces turn out as much as 250 tons. While there is a difference in the raw materials and linings for acid and basic open-hearth furnaces, both produce steel on the Siemens principle. Most American steel is made by the basic process, but the reverse is true in Europe.



SECTION THROUGH VESSEL

Although Bessemer converters vary in detail, the most commonly used type is mounted on trunnions. The air blast is introduced through one of these, and thence passes into the wind box and is fed from the latter into the tuyeres that extend up through the bottom. The skeleton of the vessel is made of riveted steel plates. The interior is lined to a thickness of from 10 to 16 inches with a refractory, siliceous material.

About 1850, two men conceived the idea of blowing air into and through a bath of molten pig iron to remove the carbon and to produce wrought iron or steel. They were Sir Henry Bessemer of England and William Kelly of Kentucky. Bessemer's patent was granted in 1855, but Kelly did not apply for his until 1857, although he was able to prove that he had worked on his process as early as 1847. The title of Bessemer's patent read: "A process for producing malleable iron and steel without the use of fuel." Kelly's first commercial vessel, a little larger than a 2-bushel basket and installed by him in 1861 for the Cambria Steel Company, is still preserved on the first floor of the office building of the Cambria plant, Johnstown, Pa., of the Bethlehem Steel Company. A protracted legal battle over the question of patents was waged by the Bessemer and Kelly interests. Kelly did not have the necessary money to continue the litigation and settled the controversy by agreeing to discontinue the manufacture of his converter.

After many failures, Bessemer finally brought his process to a commercial stage. At first he accidentally used only Swedish pig iron that had a low phosphorus and a high manganese content. When others attempted to treat English pig iron that was high in phosphorus and low in manganese, they were unsuccessful. There was so much opposition to and prejudice against his process that Bessemer was forced to start his own plant in Sheffield in 1860. There it was finally brought under control by the addition of manganese in the form of spiegeleisen, the beneficial effects of which were recognized by R. Mushet as early as 1856.

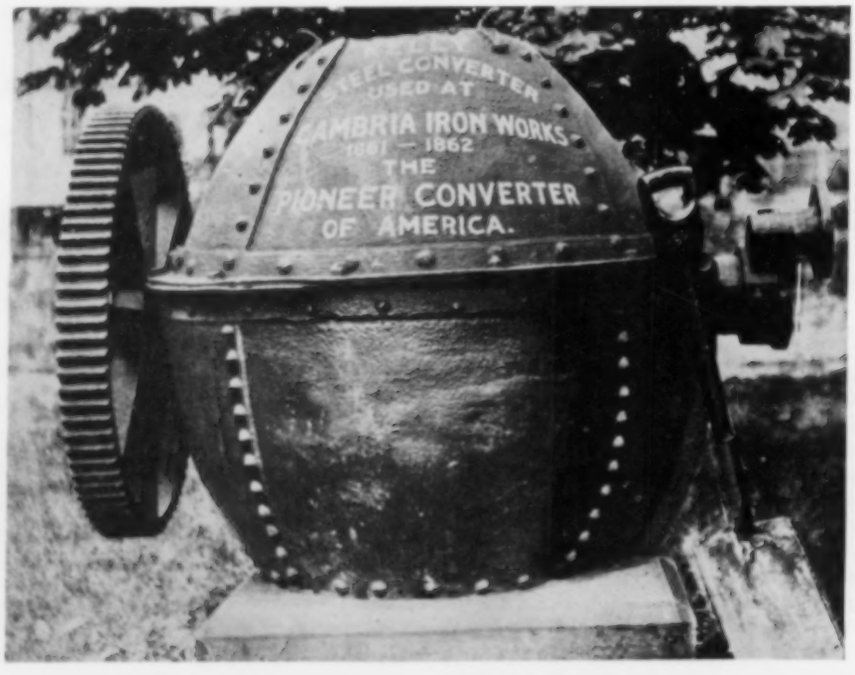
Bessemer's first tests were made with a crucible into which a refractory tube was lowered to serve as a conduit for the air blast. Since that time many different forms of vessels and methods of applying the air have been tried. These included fixed vessels with both bottom and side tuyeres, vessels like a 3-compartment septic tank, vessels in which the pig iron was melted by a set of upper tuyeres and blown to steel by a bottom set, etc. A side-blown cylindrical vessel that was used at one time has disappeared from steelworks, although it is still utilized in copper refineries. Finally, the egg-shaped vessel, mounted on trunnions and either side- or bottom-blown, became the accepted form.

The heat required for the process is generated by oxidation of the iron, silicon, manganese, and carbon. During the first part of the blow the oxygen of the blast attacks first the iron, then the silicon and the manganese, producing exothermic reactions that rapidly increase the temperature of the bath. The gases given off are chiefly nitrogen, with carbon monoxide and dioxide and traces of oxygen and hydrogen. They produce no flame; but with the rise in temperature, carbon begins to oxidize to carbon monoxide which burns to carbon dioxide at the mouth of the vessel and creates a flame outside the vessel. This heat is wasted. The rapid generation of carbon monoxide in the metal produces the "boil," and as the rate of generation of this gas increases, the flame grows to its maximum size. It gradually subsides as the carbon is burned out.

While many men have contributed to the process since Bessemer's days, two Americans should receive special credit. Alexander Holley made, among other improvements, the first successful form of removable bottom which expedited production and reduced costs. W. R. Jones developed a refractory-lined storage vessel, called a "hot metal mixer," which received molten metal tapped from several different blast furnaces. This mixer saved the original heat in the iron, it averaged the analysis, and it avoided further sulphur contamination that resulted when cold pig iron was melted in cupolas.

The Bessemer process was dominant from 1870 to 1910; but from then on it has fallen far behind the open-hearth output. In 1910 it contributed 9,000,000 tons of the total United States production of 26,000,000 tons, but in 1937 it accounted for only 3,500,000 tons of the 50,000,000-ton output. Under the impulse of the National Defense Program, however, steel companies are now putting idle converters back into service. The present annual rated capacity of all the country's converters is 7,000,000 tons, but it is said that by rehabilitating vessels not now in use the potential capacity can be raised to 9,600,000 tons. Accordingly, there is a considerable reserve that can be utilized merely by increasing the supply of pig iron. This is especially important at this time when open-hearth facilities are running at 100 per cent of their rated capacity while electric furnaces have reached 103 per cent.

As open-hearth steel can be made with a greater percentage of scrap than of pig iron, while Bessemer steel requires pig iron almost entirely, it is more economical for steel companies to utilize the open-



FIRST AMERICAN-BUILT CONVERTER

This converter was built by William Kelly of Eddyville, Ky., for the Cambria Iron Works, at Johnstown, Pa., which is now the Cambria plant of the Bethlehem Steel Company. The vessel, which is much smaller than the average one in use today, has been moved since this picture was taken to the first floor of the steel company's office building in Johnstown.

A CONVERTER BLOWING

Of all steel-mill equipment, Bessemer converters make the most spectacular visual displays. Their pyrotechnics are especially effective at night, as many persons have observed while traveling through a steel-producing area such as Pittsburgh. The average blower holds a charge of 25 tons, which ordinarily is molten metal obtained from a blast furnace. During the blowing period, 2 tons or more of the contents is oxidized. Most of this consists of impurities; but small amounts of iron also pass off in gaseous form. For many years skilled operators determined by the appearance of the flame when the blow was completed. Nowadays, the electric eye performs this service, and does it so much better that the chemical contents of the product can be much more closely controlled.

hearth process when scrap is plentiful and its price is low. This situation prevailed during the depression period. In addition, it has hitherto been easier to control the chemical content and temperature of open-hearth than of Bessemer steel, and until of late the latter has, moreover, had a high sulphur content that made it undesirable for many purposes. However, the Bessemer product is more easily welded and threaded than that of either the open-hearth or electric furnace and, consequently, has in recent years been used principally for pipes and for screw stock for the making of nuts, bolts, and screws. It also has been the source of light plates such as enter into the building of railroad cars and water tanks.

Lately, the United States Steel Corporation has developed a method of spectroscopic control that results in an improved Bessemer product; and the Jones & Laughlin Steel Corporation has devised a flame-control method that accomplishes the same end. The latter is briefly mentioned on another page in this issue. These two technological advances make it possible to produce Bessemer steel that more closely approaches open-hearth steel in quality. However, it is expected that most of the increased Bessemer tonnage will go into two fields: the erection of light structures and freight-car building, both of which are current bottlenecks. Bessemer steel is in favor now for the reason that it can be turned out far more quickly than can open-hearth steel, and time is of great importance from a defense standpoint.

Because there has been a feeling for many years that the Bessemer process was on its way out, little thought has been given to its improvement. It involves two distinct phases: the mechanical delivery of the air to the molten metal, which may be called the pneumatic phase; and the chemical combination of the oxygen in the blast air with the "fuels" in the molten metal, which may be termed the metallurgical phase. One bibliography shows that less than 10 per cent of 170 papers published on the Bessemer process deal with the pneumatic phase. In other words, 90 per cent of them are concerned with the results of the combination of the oxygen with the fuel and only 10 per cent wi h the delivery of the oxygen to the vessel to burn the fuel. This seeming neglect of the pneumatic side of the question is to be deplored, because any substantial betterment in this direction would lower the blowing cost, improve the service life of converter bottoms, and improve the quality of the product.

The Bessemer vessel now ordinarily used is egg- or pear-shaped and is supported by trunnions. One of these trunnions is hollow, and the air passes through it and is led to the wind-box assembly at the base of the removable bottom. The latter is of a refractory material and has holes in it through which the tuyere blocks extend like harrow teeth. Together with the tuyeres, it makes up what is called the bottom assembly. Each tuyere block is from 26 to 36 inches long, and extending through it are from ten to thirteen holes each ½ inch in diameter, or seven holes each ⅝ inch in diameter. The air is delivered by a blowing engine or centrifugal blower to the beginning of the blast line that leads to the control platform (called the blowing pulpit), from 200 to 3,300 feet away. The operator on the pulpit can regulate the amount of air admitted to the vessel by means of a throttle valve and also can control the tilting of the vessel for charging it, blowing it, and emptying its contents after the blow is completed.

There is no accepted standard for rating Bessemer vessels such as there is for blast furnaces, nor, unfortunately, is there any symmetry as regards the capacity of the blowing engine, number of tuyeres or square inch of tuyere-hole area per bottom, and blast pressure. Consequently, four existing vessels of the same physical dimensions having blowing capacities ranging from 32,000 to 40,000 cfm., containing from 27 to 35 tuyeres, and using available blast pressures of from 26 to 35 pounds, gauge, are all rated as 25-ton vessels. To make the rating more complicated, plants sometimes blow for only about four minutes to remove a little carbon from the metal before delivering it to an open-hearth furnace and at other times blow for fifteen minutes or longer to produce dead soft steel.

In practice, the blast pressure at the pulpit control valve may range from 18 to 35 pounds, and only a few plants know the pressure lost between the pulpit and the vessel, or the true pressure in the wind

CENTRIFUGAL BLOWERS SERVING CONVERTERS

Converter air was formerly supplied first by blowing tubs and then by reciprocating blowing engines. Nowadays, centrifugal blowers are generally used for this service. The three turbine-driven units shown here can each deliver from 25,000 to 37,700 cubic feet of air per minute at 25.5 to 34 pounds gauge pressure.

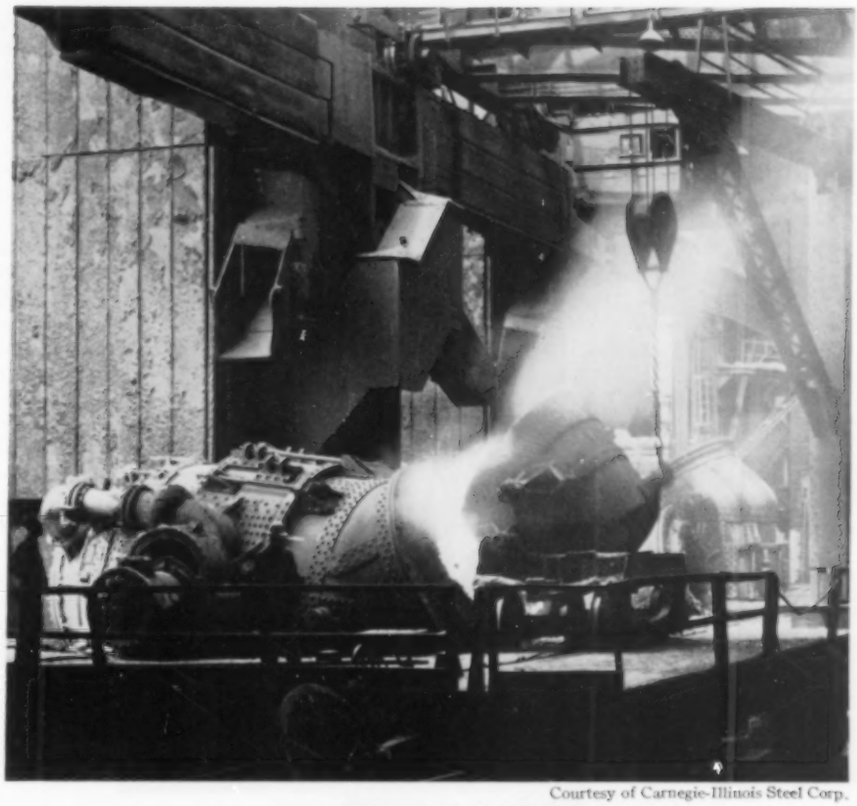
box. At one there was a 9-pound loss. The temperature in the wind box likewise may vary from 60 to 350°F., depending upon the atmospheric temperature, the blast pressure, and the length and degree of exposure of the blast line. In only a few cases are permanent records kept of the volume of air blown. At one plant a vessel of 20-ton capacity is blown with 18,000 cubic feet of air per minute at 20 pounds pressure at the pulpit, and in another an identical vessel is blown with 30,000 cfm. at 30 pounds pressure. Yet both use about the same amount of air, the reason being that the first plant blows a heat about twice as long as the second plant.

The percentage of silicon, manganese, and carbon in the pig iron entering a vessel is variable, as is also its temperature. It is possible to ascertain in advance of the blow the weight of the fuel that is to be consumed; but the writer knows of no plant where this is being done. It would seem that such information would help the operator to determine the most effective blowing practice, especially if he had visual indication of the actual amount of air leaving the blower. At present, a heat may be blown as little as three minutes or as much as 25 minutes, depending upon the tuyere area, the analysis and temperature of the iron, and the quality of blown metal desired.

Because of all these variables it is impossible to correlate the results of two plants. Blast-furnace operators have a measure of comparison based on 50 cubic feet of air per pound of coke, and furnaces of like capacity and burden show about the same blast pressure. Inasmuch as it is obvious that any decrease in the pressure or the volume of the air blast fed to a converter would effect economies provided the blowing time were not extended, it would seem that there is ample justification for devoting more attention to the pneumatic phase of the Bessemer process.

There has been a feeling in the past that while horsepower could be saved by reducing the blast pressure, it was nevertheless necessary to maintain minimum pressure at the pulpit to keep the metal out of the tuyeres. An operator who had been trained to use 30 pounds pressure hesitated to reduce it to 20 pounds. On the other hand, a man accustomed to using 20 pounds was afraid to increase the pressure lest he blow the charge out of the vessel. Both overlooked the fact that there is a close relationship among blast pressure, blast volume, blast temperature, tuyere area, and duration of blow.

Most of the old-time operators were trained in plants where the air was delivered by reciprocating blowers. It is customary to think that the blower is responsible for the pressure, whereas all it does is move a certain number of pounds of air per minute from the atmosphere into the blast line. The resistance offered by the tuyeres to the escape of this air, plus the friction in the pipe line, determine the pressure at which the blower delivers.



Courtesy of Carnegie-Illinois Steel Corp.

A TON OF STEEL A MINUTE

Bessemer vessels convert pig iron or blast iron into steel at the rate of about a ton a minute. A 25-ton converter is shown here being charged with molten metal. It was obtained from the mixer in the right background in which iron from two or more blast furnaces is brought together to obtain a uniform analysis and where it is held in the molten condition until it goes to the converters.

As the tuyeres burn off in service, less resistance is offered to the passage of the air, and the same amount of air can be blown at a lower pressure or a larger amount at the original pressure. Because a reciprocating engine delivers a substantially constant amount of air at a given speed regardless of pressure, it will meet this new condition merely by operating at a lower pressure but with little increase in capacity. As contrasted to this, a centrigual blower of the type now generally installed will deliver appreciably more air against the decreased resistance. Therefore the duration of the heat will be shortened and production increased.

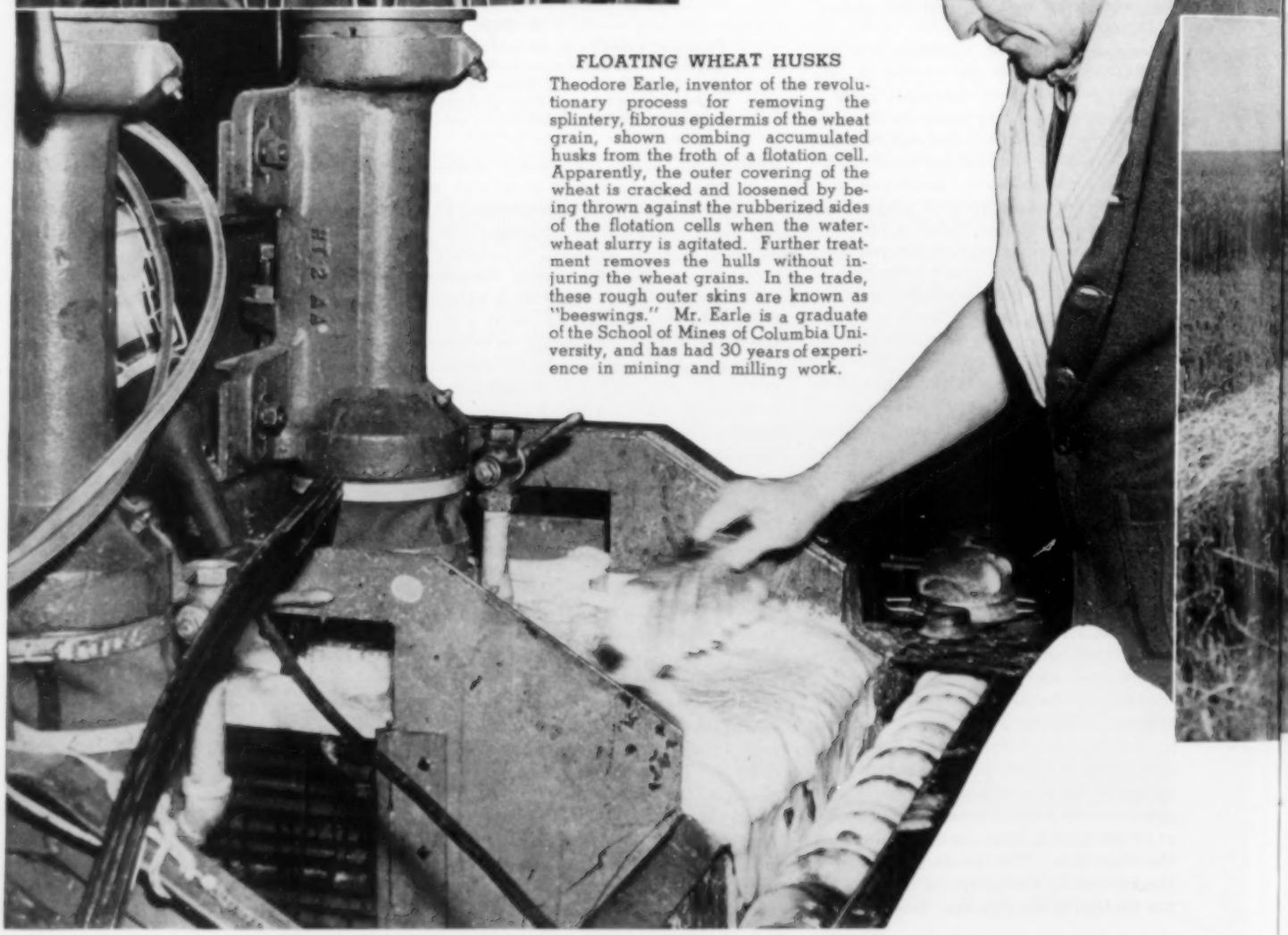
Because higher temperature means greater volume and increases the velocity of the air through the tuyeres, it is probable that greater efficiency in converters could be obtained by preheating the air blast and by insulating delivery lines to retain the heat, especially where the lines are long. It is indicated that this would save horsepower at the blower.

Better distribution of the air in its delivery to the converter also may be possible. Under the prevailing design, as many as 245 holes are fighting for air that reaches the wind box at a single point, and it is reasonable to assume that not all of them can obtain the same volume or cubic feet per minute at all times. The usual failure of certain tuyeres after a given number of heats perhaps results from this tug of war. A better distribution of the air to the tuyeres might be insured by running an inner and outer ring of pipes around the inside of the wind box, with each ring supplying the tuyeres in its area.

There may also be room for improvement in the location of the tuyeres. Although it is a debatable matter, the majority opinion is that the molten metal, under the violent agitation to which it is subjected, moves up the center of the vessel, returns down the sides, and thence flows back to the center to begin another cycle. There is reason to believe, however, that the jets of air leaving the outer ring of tuyeres at a velocity of around 1,200 feet per second erect a pneumatic picket fence that interferes with the flow of the liquid across it and also induces an upward movement between the tuyere blocks in this ring. If true, this would leave the central group of tuyeres working on much the same batch of metal all the time, and the temperature in the center would be higher than elsewhere because the outer layer would be cooled by radiation. Redistribution of the tuyere blocks might give the metal a better chance to get back to the center of the vessel and likewise decrease the rate of bottom retreat, which is now higher in the center than elsewhere.

Flotation Gives Us a New Bread

Frank L. Baer



FLOATING WHEAT HUSKS

Theodore Earle, inventor of the revolutionary process for removing the splintery, fibrous epidermis of the wheat grain, shown combing accumulated husks from the froth of a flotation cell. Apparently, the outer covering of the wheat is cracked and loosened by being thrown against the rubberized sides of the flotation cells when the water-wheat slurry is agitated. Further treatment removes the hulls without injuring the wheat grains. In the trade, these rough outer skins are known as "beeswings." Mr. Earle is a graduate of the School of Mines of Columbia University, and has had 30 years of experience in mining and milling work.

IF ANYONE had predicted that a mining engineer would solve the problem of peeling the fibrous, indigestible hull or epidermis from wheat grains, a problem that has baffled scientists for more years than they care to recall, the millers and bakers would have asked: "Are you kidding? What does a man in that profession know about milling?" Nevertheless, the wheat-peeling discovery was made by a mining engineer—Theodore Earle of California, and he did it by means of the flotation process that is used to separate precious metals from baser elements and dross. The Earle process is producing a new kind of flour from which bread is being baked daily and delivered to consumers in more than 100 important cities in the United States.

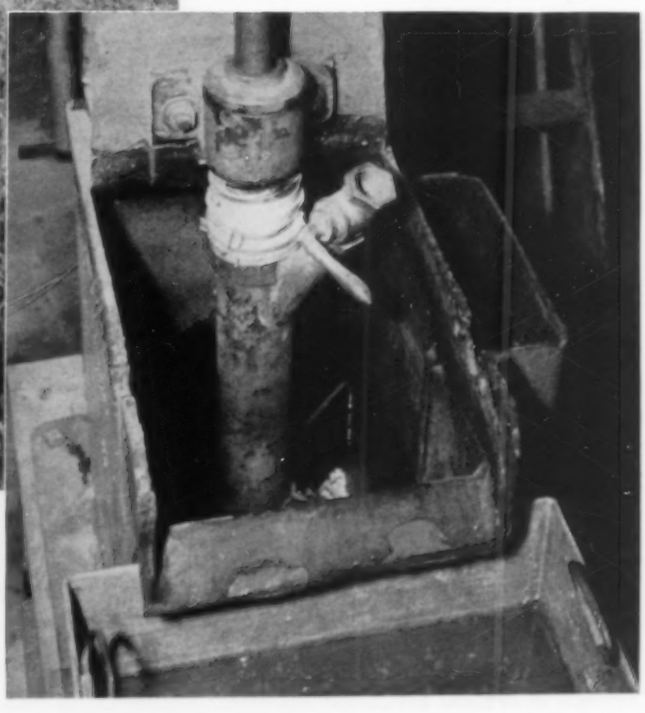
Millers have long admitted that the hull or outer coating of the wheat berry should come off; but how to get rid of it without releasing the vitamin, mineral, and protein deposits in the bran coats just under the epidermis, that's been the question. White bread baked from refined flour from which these rich health elements have been removed has been criticized for decades by dietitians and food authorities. Recently, an "enrichment" program calling for the restoration of these constituents has been adopted by millers and bakers; but the process calls for the use of synthetic vitamin concentrates. Earle flour requires no fortifying: the natural vitamins, proteins, and minerals of the wheat are retained in full strength, just as they are produced in the course of the grain-growing period, and carry over into the bread baked from it. Consequently, the consumer gets a bread that is "nature vitaminized."

Theodore Earle did not develop the wheat-peeling method through experiments made in an attempt to find it. He came upon it in a roundabout fashion while testing seeds to determine their fertility strength. In his laboratory at Pacific Palisades he has for years conducted seed tests as a hobby, and he has made some startling discoveries. One, for example, makes it possible to classify seeds so completely as to milling and planting properties that grain acreage can be increased as high as 22 per cent through scientific selectivity. This process also involves the use of flotation cells.

In the course of testing the germinating properties of wheat, Earle found that some kernels floated and others settled. Those that came to the top proved to be the best for germination, while those that sank made the best flour. Working with grain seeds of different varieties, he had on one occasion mixed a slurry—water and wheat grains in measured proportions—and placed them in a flotation cell. When the mass was well agitated by the action of an impeller, he added a reagent to create a foam or froth on the slurry surface in which the foreign particles could collect and be piped off. In the midst of that experiment he was called to the telephone. The conversation stretched itself out, and he remained at the 'phone longer than he had expected. When he returned to the flotation cell he was surprised to discover that the grains of wheat had been freed of their outer hulls and that the slivery flakes of the epidermis were snared in the froth.

Then came months of follow-up work to test his findings. Being a man of secured financial standing, Earle was able to take his time to prove what he had discovered. He conducted tests with the peeled grains; had them ground into flour; kept them in storage for long periods to determine whether or not they would become rancid; and made no attempt to develop his process commercially until he was absolutely certain that he had what he thought he had. When he had satisfied himself as to the correctness of his find he went with it to M. Lee Marshall, president of the Continental Baking Company. The latter recognized its importance and undertook to test the process for volume production of vitamin flour.

The Marshall-Earle developments paralleled the period when nutrition was beginning to claim more national attention and just before President Roosevelt called the National Nutrition Conference for



ORIGINAL EXPERIMENTAL CELL

It was while he was testing grains for their germinating properties that Mr. Earle made the discovery that the husks of wheat could be removed by flotation. He left some wheat in the cell shown at the right while he answered the telephone. The conversation was prolonged and, upon his return, he was surprised to find that the outer skin of each kernel had become detached. Shown above is a Canadian wheat field.

Defense. Marshall purchased an old flour mill in Kansas City, Mo., and turned it over to Earle. The latter's first step was to ask the Denver Equipment Company, ore-milling specialists, to supply suitable flotation equipment. The machinery was delivered early this year. Four months to the day after the mill was taken over, flour flowed into the bins, and this was immediately followed by the baking of a new natural-wheat bread named Staff. The Kansas City mill is now producing 1,000 barrels of flour a day, and a second mill will soon go into operation in Minnesota.

The procedure of receiving, binning, and rough cleaning wheat under the Earle process is the same as that practiced by all good millers. The Millerator removes the corn, chaff, straw, stones, dirt pellets, and other foreign matter. The Carter Disc takes out the oats, weed seeds, broken grains, and shriveled particles. Then the grain is sent to the first flotation cell. Ten cells, interconnected at the base by pipes, constitute the peeling machinery. They are in the form of rubber-lined tanks each of which is equipped with a rubber-covered impeller. The slurry of wheat and water mixed in proper proportions enters the first cell and is agitated by the impeller. Then a reagent is added to form a froth which serves to collect the thin fibrous epidermis of the wheat as it breaks away from the kernels. As the slurry flows from cell to cell, the hull material is held at the tops of the cells and the grains drop to the bottoms. The froth becomes a mass of wet material resembling wood shavings and is piped off as it accumulates.

Passage of the wheat from cell one to cell ten takes about nine minutes, and at the discharge end the kernels are fed on to a vibrating screen which shakes much of the water from them. The peeled grains then pass into a whizzer—a continuous type of centrifuge—where they remain for a few seconds to remove any adhering bubbles of moisture. From there they go to a drier through which warm air is circulated. This is a steel tube, 5 feet in diameter and 30 feet long, fitted with a large central flue and six concentric tubes. The kernels stay in it for twelve minutes, moving at high speed and tumbling finally into an aspirator where any husks stuck in the creases of the grains are withdrawn. Still feeling moist to the touch, the berries are poured into huge tempering tanks where they are left for several hours to undergo a natural drying period. At the end of that time they emerge externally free of moisture. Now ready for grinding, the cleansed, peeled wheat goes to a battery of five 24-inch-high Mikro-Pulverizers of hammer-mill design and is turned into flour that contains all the nutritive properties in the bran coats of the kernels and none of the woody outer epidermis that frequently causes stomach disorders and gastric upsets.

Staff is a vitamin bread. The flour contains 965 International Units of vitamin B_1 per pound as against 75 to 100 International Units per pound in patent white flour. The high content is explained by the fact that wheat rich in protein enters into the flour-milling process. Only No. 1 dark, hard winter wheat testing 61 pounds (minimum) to the bushel and 15 per cent or more of protein is used. Analysis reveals that a typical loaf contains 37.40 per cent moisture and 62.60 per cent solids made up as follows: protein, 15.92 per cent; ash (less salt), 2.13 per cent; salt (NaCl), 2.17 per cent; crude fiber, 1.71 per cent; crude fat, 6.31 per cent; and carbohydrates, 71.76 per cent. The importance of the flour, and, in turn, the bread made possible by the Earle process is that they provide all the nutritive elements—the health and stamina-giving constituents—of the wheat kernel while eliminating the objectionable feature of whole wheat.

COMPARATIVE TABLE OF MINERAL CONTENT

Minerals	White Bread Per Cent	So-Called Whole-Wheat Per Cent	Staff Per Cent
Total Minerals	1.0300	1.1400	2.1300
Calcium	0.0270*	0.0500	0.0840
Phosphorus	0.0930*	0.2180	0.3800
Iron	0.0009	0.0025	0.0049

Dr. John R. Murlin, of the University of Rochester, N.Y., told the Nutrition Conference delegates that instead of injecting into white flour "certain factors which are now available in chemically pure form" why not "restore all the factors" that milling has removed. "At the present time," he emphasized, "that can be done in only one way, namely, by producing whole-wheat flour and making whole-wheat bread. In case we have a period of stringent emergency and, of course, we may have it earlier than we expect, such facts as the following will be of interest:

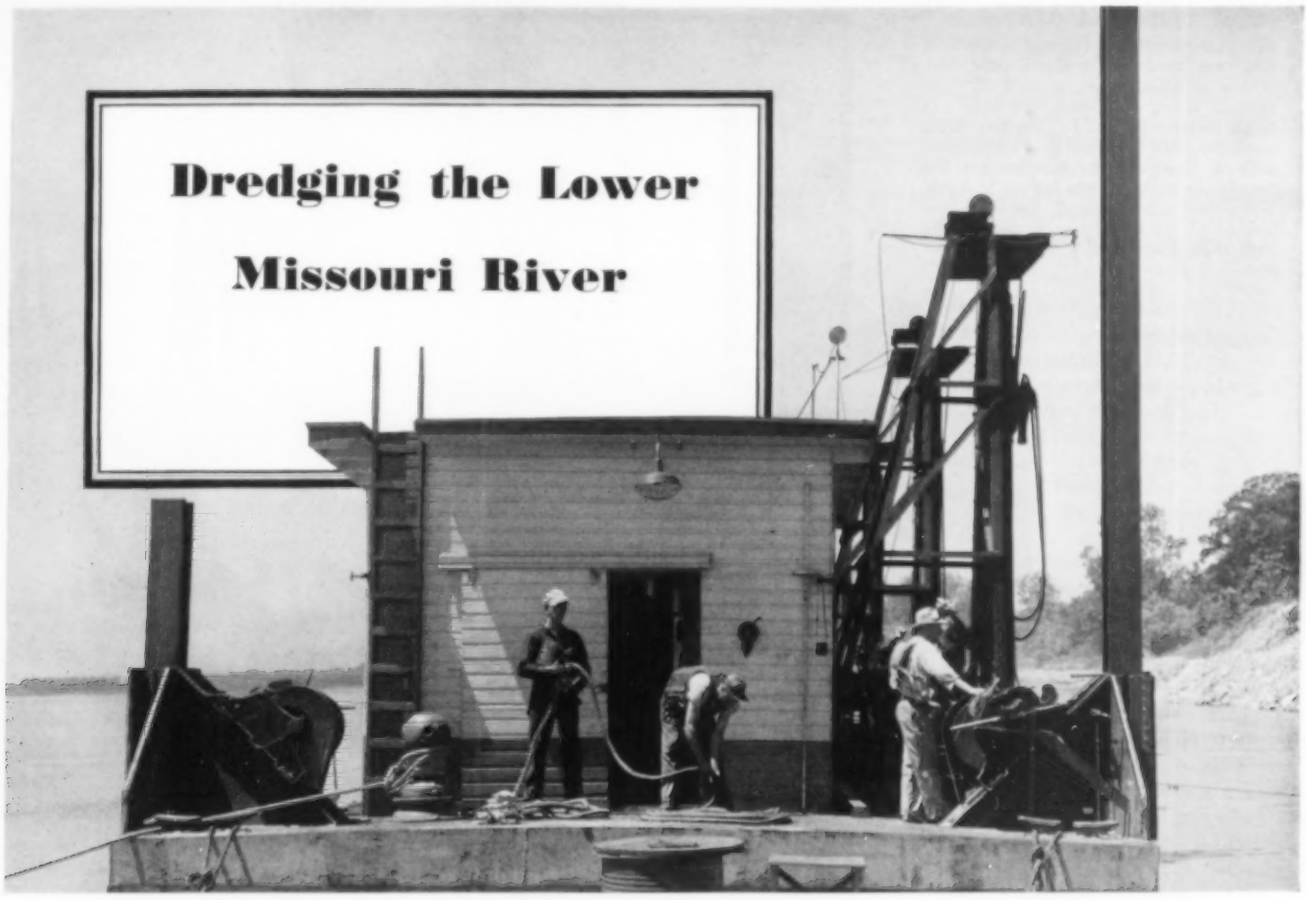
"The economic saving of whole-wheat bread over the common, lean white loaf. The average per capita consumption of wheat is 4 bushels, or 240 pounds. Deprived only of its roughest constituent, 2 per cent only by weight, and ground without sifting or bolting whatever, that amount will make 355 pounds of bread as compared with 221 pounds on a rich formula from 73 per cent extraction of the grain. The 355 pounds of whole wheat, according to digestibility figures in a recent experiment in our own laboratory on ten men, would yield 356,000 and some odd calories, compared with a white bread of 240,000 and some odd calories eaten by the same men, a saving in food of 116,000 calories, or enough to support the average man on our diet squad for 36 days. In other words, eating whole-wheat bread would save something over a month's supply of energy for yourself in the course of a year."

WHEAT-GRAIN HULLS

The discharge from a flotation cell, consisting of a froth containing the fibrous husks. It has been suggested that they be used as an insulating material for houses.

*Figures are on a dry basis. If made with milk, the calcium will average 0.0568 per cent and the phosphorus 0.1009 per cent.

Dredging the Lower Missouri River



STERN OF DRILL BOAT

Showing one spud raised and another lowered. Each of the four spuds was originally fitted with a hand-operated Bebee hoist with a 10,000-pound rope pull. To speed up the movement, a BBSC air motor was attached directly to the back gear-drive shaft to do the work of the hand crank. Two of these, serving the spuds on the side of the boat where the drills are mounted, have now been replaced with more powerful AAC air motors.

THE Missouri, often called the Big Muddy, is famed in the annals of river boating and has played a prominent part in the history of the West. It was up this turbulent stream that Lewis and Clark journeyed in starting on their historic exploration of the great Northwest, and later it became one of the principal routes in the westward migration. Today it is an artery for commerce, powerful towboats bringing grain barges down from the western plains and returning them laden with manufactured articles. Combined with the lower Mississippi, the Missouri forms one of the longest river routes in the world and probably one of the most unpredictable. Its shifting sand bars and frequent fluctuations in stages, as well as its propensity for suddenly eroding a farm here and depositing it there, have demanded unceasing vigilance and persistent work to keep the stream navigable and to lessen the dangers of floods.

There has recently been undertaken a program of stabilization that has for its object the controlling and harnessing of the Big Muddy's wayward energy. As a step in this program of stabilizing the erratic river and keeping it navigable during the shipping season, the Corps of Engineers, U.S. Army, Kansas City District, has completed with Government plant and hired labor the first extensive rock-removal work ever done on this waterway. The plans formulated necessitated relocating and deepening the channel at eight different points within a stretch of approximately 200 miles in the lower reaches and building rock dikes with material excavated. The areas involved aggregated 2,670,971 square feet, and the specifications called for the removal of 394,971 cubic yards of rock to a depth of 12 feet below the construction reference plane (mean low water) on a side slope of about 2 on 1 from the shoreward channel line.

Operations were begun on March 16, 1940, and the same general procedure was followed on each of the eight jobs. A survey party first laid out a base line adjacent to the rock area to be excavated and established ranges every 50 feet perpendicular to the channel line. These ranges were marked on the bank by two stakes, one near the water's edge and one about 100 feet landward. On the one close to the water was marked the distance between it and the channel line; and the ranges were numbered consecutively beginning with the upstream end of the working zone. Cross sections were established along these ranges before and after dredging to estimate the yardage removed; and by means of a tag line or stadia measurement from the landward stake it was possible for the drill boat and dredges to determine the channel line as well as the outer limit of the rock area.

In view of the fact that the Kansas City District had never carried out any large-scale subaqueous rock-removal operations, it was necessary to redesign and to enlarge the available equipment. The U.S. Engineer boatyard at Gasconade, Mo., fitted out the vessel used for drilling and blasting. It has a steel hull, 100 feet long and 24 feet wide, and is provided with four spuds, one at each corner. These consist of 8x8-inch steel H-beams 30 feet long and reinforced with two 10-inch channels of the same length. They are moved up and down by individual, reversible, air-operated motors attached to gear-driven hoists, rectangular steel housings on the outside of the hull serving as guides. When lowered, the spuds anchor the drill boat firmly, or when any three are raised, the one left in position

THE DRILL BOAT

The vessel as it was refitted at the U.S. Engineer boatyard at Gasconade, Mo. It has a 100x24-foot steel hull, and ranged along the starboard side are three Ingersoll-Rand X-71 drifter drills each mounted in a steel tower equipped with a floodlight to supplement the regular lighting system for night work. Not being self-propelled, the craft was moved about by a launch during the operations described.

permits the vessel to pivot at that point.

Ranged along one side of the boat are three air-operated drifter drills each of which is mounted in a separate tower with a vertical column and leads for lifting and lowering it. The towers travel on a 75-foot-long track laid on the deck and can be spaced longitudinally within those limits as may be desired. Each is moved through the medium of rack-and-gear drive powered by an air-operated motor at its base and is equipped with an outrigger platform for changing drill steels and drill bits and for loading dynamite into the holes. These working spaces have guard rails in accordance with Government safety regulations. Each drill operates through a "mud pot" carrying a 4-inch sand pipe of variable length, the whole assembly being attached to the associate rig in such a way that it can be lowered to keep mud and sand out of a hole while it is being drilled and loaded. In the event solids do seep in, they are blown out with a compressed-air jetting pipe. A number of these are available, and were used on the project in question for cleaning out the drill holes and to determine with accuracy the elevation of the surface of the rock. It was from these probings that the cross sections of rock were plotted along each range before drilling.

The drill boat is not self-propelled and therefore had to be shifted from one location to another by a launch, which also transported explosives and supplies. After the drill boat was spotted, anchors, attached to several hundred feet of line, were dropped riverward and upstream and lines were run to shore, thus permitting it to be moved crosswise of the current throughout the working area. Usually a long head line was run to some point upstream to prevent the vessel from drifting down with the current while being moved in or out. All these lines were operated from an air-powered winch at the bow and a manually operated capstan at the stern.

CONSTRUCTING A DIKE

The excavated material was towed to the sites of the dikes by barges and unloaded by draglines. In most cases, one was used to build the dikes up to a point a few feet above water level and a second one completed the crown.

DRILL RUNWAY

Below is shown a section of the 75-foot track along which the drills are moved by rack-and-gear mechanisms. This track is marked at 1-foot intervals to assist in spotting the holes with accuracy. An air-line outlet is located at the center of the span traversed by each drill rig, and the hose connection reaches to the end of its zone of travel.

OUTRIGGER PLATFORMS

An outrigger platform and steps were constructed at the base of each drill tower for the workmen. This picture shows two drills in the raised position with the "mud pots" and 4-inch sand pipes visible. While the holes are being drilled and loaded with powder they are lowered so as to keep out mud and sand.

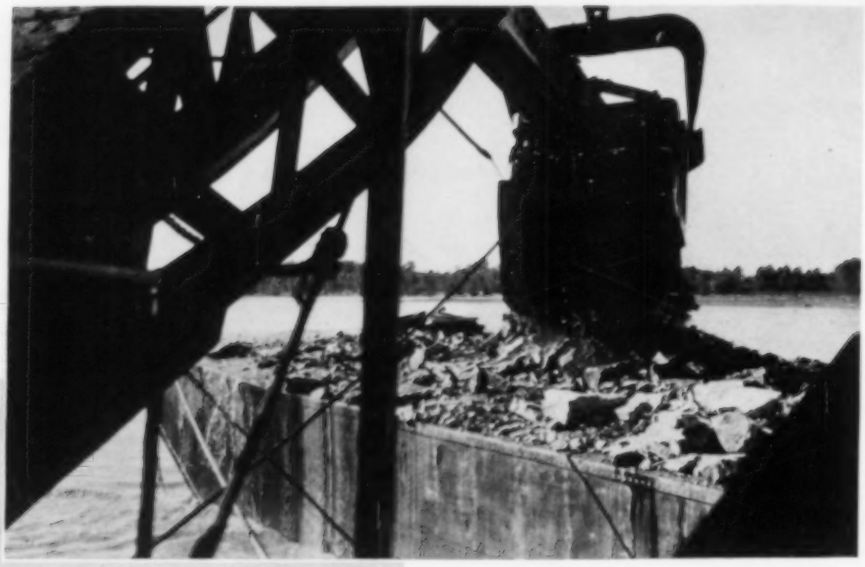
The superstructure of the drill boat is a 1-story wooden housing divided into two sections. One of these is suitably outfitted as an office, and the other larger space contains the main air compressor, which has a capacity of 1,000 cfm. and is driven by a 210-hp. oil engine, a small electric-driven compressor that supplies starting air for the engine, a main air receiver that furnishes air for the drills, a 10-kw. generator for the lighting system, a clear-water system, and a workbench, storage bins, and cabinets for parts, tools, and equipment. Two 1,500-gallon fuel tanks are built into the hull.

Before actual drilling could be undertaken it was first necessary to remove any excessive overburden with a dipper dredge, of which two were on the job. These sufficed for gravel and loose rock; but where a heavy overburden of sand was encountered, one of the District's dustpan-type dredges was called into service. The material was spoiled along the river bank shoreward of the rectified channel line. With these preliminary operations finished, drilling could be started. The boat carried a reel and a tag line at each end, the latter being marked off at 7- or 10-foot intervals, depending upon whether succeeding rows of holes were to be put down on 7- or 10-foot centers. This method obviated surveying each time the vessel took up a new drilling position. The spacing of the holes in the longitudinal direction was done by shifting the drill towers back and forth on their track, which previously had been marked at 1-foot intervals. Therefore, with this one set-up of tag lines and shore stations, it was possible for the drill boat to cover an area 75 feet long and up to 250 feet wide—the maximum width of the rock areas.

Inasmuch as the rock in the lower Missouri is nearly all limestone, though of varying degrees of hardness and stratification, the spacing of the drill holes varied

DREDGING OPERATIONS

It was originally expected that one 4½-cubic-yard dredge would be capable of handling all the material drilled and blasted; but after a few weeks it was found that it could not keep up with the drill boat. A second 4-cubic-yard dredge was therefore put in service. The pictures show one of the units working in the river and a close-up of a dipper dumping its load on a barge.



from 7x7 feet to 7x10, 10x10, and 10x12 feet, the wider intervals predominating. The holes were staggered so that those in one row would not fall directly in line with those in the preceding one. The side slope was obtained by drilling the first row short of the regular depth. This worked very well because the shoreward edge of the channel invariably had a heavy face of rock, often as much as 9 or 10 feet. On the riverward side, however, the last row of holes often had a foot or less of rock above grade, and overdepth drilling had to be increased to 5 feet or more to make sure of shattering all the rock between holes.

Each hole was loaded with dynamite as soon as it was drilled and then wired in series to the adjacent hole. As in all subaqueous blasting, particular care was exercised to make all wire connections waterproof in order to eliminate short circuits. The drill bits used were 3½ inches in diameter when new (their size was gradually reduced by resharpening), permitting the holes to be loaded with 2½- or 3-inch sticks of dynamite. Electric blasting caps served throughout. When a section of from 20 to 100 holes was drilled, the launch moved the drill boat to a safe distance and the charge was fired with a plunger-type detonator. To insure removal of the rock to grade, the holes were drilled 3 to 4 feet overdepth, and the dynamite charge was varied from 1½ to 2 pounds per linear foot of hole.

The diversified structure of the rock presented other problems which necessitated changes in the spacing of the drill holes or in the amount of overdepth drilling. Inasmuch as a clay seam near the bottom of a hole might have allowed the force of the blast to be dissipated through the seam, it was the practice to stop such holes at the top of the seam and to put a little heavier load in the upper part. In some localities the upper foot or so failed to shatter, although the rock below was thoroughly broken up, giving the impression, when the dredges moved in, that the area was not blasted. However, once the dredge succeeded in getting the dipper teeth under the large top slabs, digging was comparatively easy. Fissures in the rock also impeded progress because the drill steels occasionally became jammed. However, in most instances it was possible to recover them by unscrewing them from the detachable bits.

In certain areas the water was too shallow during the dry season to float the drill boat over the higher rocks. When a rise did not occur before the work in that locality was completed, the holes were put down with an air-driven drill from a shallow-draft pontoon. This slowed up operations and also limited the size both of the hole and of the charge that could be placed in it. Some of the large submerged boulders encountered, slabs of approximately 5x15x25 feet, had to be removed by aid of the drill boat. Smaller ones were rolled to shallow water or to the bank by the dredges and were broken up there by dobying.

Four-point, 3½-inch-gauge, side-hole Jackbits were used exclusively and reground as required. The average bit was good for four or five regrinds, and gave approximately 40 feet of drill hole per grind. The extremely hard rock strata often wore the drill bits down in 6 linear feet of drilling, and under such severe service even resharpening could not prolong their life to any great extent. When they were worn down to 2½ inches they were discarded. In one area a type of jack ore—a hard limestone and flint formation impregnated with lead and zinc sulphide—was encountered, and this lodged in the wing clearance spaces, locking the bits and steels in the holes. Most of the steel breakage and loss occurred in this locality.

Drilling, in hrs.	2,856
Loading, in hrs.	889
Blasting, in hrs.	493
Total effective working hours	4,238
Noneffective working hours	1,686
Repair time, in hrs.	124
Idle time, in hrs.	1,680
Total noneffective hours	3,490
Total hours	7,728
Number of holes drilled	23,781
Area blasted, in sq. ft.	2,670,971
Total linear footage drilled	170,616
Average depth of hole, in ft.	7.2
Total pay rock drilled and blasted, in cu. yds.	394,710
Dynamite, in lbs.	345,000
Number of detonators used	25,000
Number of drill rods in service	150
Number of Jackbits used	1,025
Fuel for main compressor, 42-gal. bbls.	535
Lubricating oil for all purposes, in gals.	1,250

Many of the difficulties experienced were due to natural factors such as variable river and channel conditions and variations in the density and composition of the material removed. One of the most annoying situations developed at the beginning of the season. The Missouri suddenly rose and brought downstream heavy drift that sometimes lodged against the wires connected to the blasting caps, often breaking them. Locating these wires and repairing them resulted in considerable loss of time. This problem was solved by employing blasting caps with especially strong wire and heavy double insulation. However, when the river was so high that the longest drill steel on hand could not reach the desired depth, operations had to be suspended until the water receded.

Each job had to be planned carefully so that the drill boat could be kept well in advance of the dredges and of the two draglines that were used to build the dikes adjacent to the areas being dredged. Before operations were begun, it was expected that the vessel would be able to keep one 4½-cubic-yard dipper dredge busy. However, after a few weeks, the dredge fell so far behind that an additional one with a capacity of 4 cubic yards was transferred to the site. Even then the boat had no difficulty in drilling and blasting enough material to keep ahead of the dredging equipment. In fact, while the two dredges were clearing away the rock in the next to the last of the eight areas, a large floating dragline was put to work removing the blasted material on the last job of the season. This dragline is mounted on two steel barges welded together to form a 60x120-foot base. It is steam powered; provided with a 6½-cubic-yard, high-arch bucket attached to a 1½-inch cable; and has a 185-foot boom that enables it to dig over a large area. It was anchored by four 1⅛-inch cables that were run to deadmen on shore and to piling driven into the river bed. The remainder of the plant consisted of a shop boat, several launches, fuel barges, and barges for transporting rock. The men were housed on quarterboats that followed the work; and a radio receiver and transmitter on one of the latter kept the District office in continual touch with the operations.

Following the blasting of a sizable section, the dredges moved in and started picking up the material. It was found that one dredge, in the case of a heavy face of rock, could clean up a cut about 20 feet wide. The cuts were made lengthwise of the working area, starting on the outside and moving progressively shoreward. The rock was loaded on barges and towed to the sites of the dikes where the draglines unloaded it. As most of the sites were out in the water, it proved to be more efficient to use one dragline to build the base up to a few feet above the surface of the water and to complete the crown with the other dragline following at a safe distance. The center lines for the dikes were determined by projecting lines from stakes which had been set on the bank.

On the last job, which involved the removal of 60,000 cubic yards of material, the large floating dragline could, because of its long boom, place the rock directly on the dike line and therefore turned out to be the most economical of the excavating equipment used. But even so it could not keep pace with the drill boat when both were operating on a 24-hour-a-day basis. The specifications covering this area called for two dikes with wide crowns measuring 24 and 45 feet. In this case the floating dragline and the unloading dragline were supplemented by a bulldozer to spread the spoil.

When each job was completed, the entire area was checked for high spots by sweeping it with a barge from which a railroad rail was suspended at a fixed point below the surface of the water. For the purpose of keeping track of the drill boat's performance, it was supplied with mimeographed sheets showing the arrangement of the holes. By marking the holes in different colors, one for each of the three shifts employed, it was possible to determine how many each drilled in the course of a day. With the number of the range and the elevation of the rock at each hole filled in, these sheets represented a correct and graphic day-by-day record of the work. As the rock was cleared away the dredges took soundings. These after-dredging soundings provided the additional information needed to arrive at the quantities removed in the respective cross sections and to complete the progress charts and the daily reports of operations. The dredges checked their distance from the channel line by tag line or stadia measurement and noted their advance by the perpendicular range stakes. In this same way, whenever a high spot was found, it could be accurately shown on the map for redrilling.

The working season extended from March 16, 1940, to January 31, 1941, a total of 322 days. Throughout this period the plant operated 24 hours a day with 70 days lost time, as follows: five for repairs, eight at Christmas, and the 57 others because of high water and transferring between jobs. A total of 23,781 holes was drilled, or 170,616 linear feet, an average of 7.2 linear feet per hole. The average depth of hole below grade was 3.2 feet. Of the total time the drill boat was considered in operation, 48.2 per cent—2,856 hours—was spent in active drilling and the remainder in loading holes, blasting, moving to new set-ups, and repairing broken wires. In addition to the 394,710 cubic yards blasted, the dredges and floating dragline removed 14,547 cubic yards of material suitable for dike building and 178,374 cubic yards of overburden, making a total of 587,631 cubic yards dredged. Of this amount the floating dragline is credited with having moved approximately 70,000 cubic yards. The results obtained exceeded expectations, both in the amount of work accomplished and in the low operating cost.

The completion of this step in the stabilization of the Missouri by the U. S. Army Engineers has given the river a channel throughout the rock areas deep enough to accommodate shipping not only under the present program, which calls for a depth of 6 feet, but also in the event a 9-foot channel is authorized.

DRILL-TOWER BASE

Each of the three drill towers is fitted with three I-R air hoists—two size EU units and one size D6U. One of the former raises and lowers the main column on which the drill slabback is carried, and the other is used to operate the rack-and-gear mechanism by which the tower is moved along the 75-foot track. The D6U hoist handles the slabback drill mounting on the column.

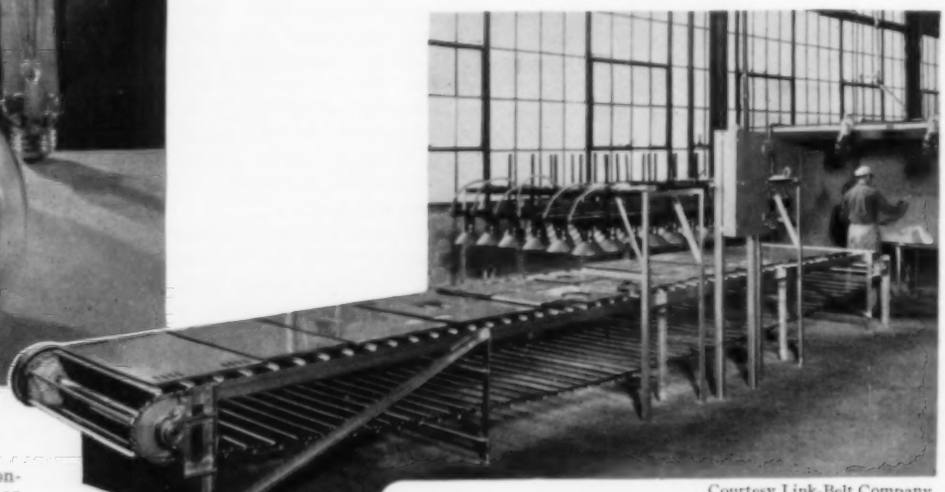
Infrared Lamps Eliminate a Bottleneck in Industry

A. M. Hoffmann

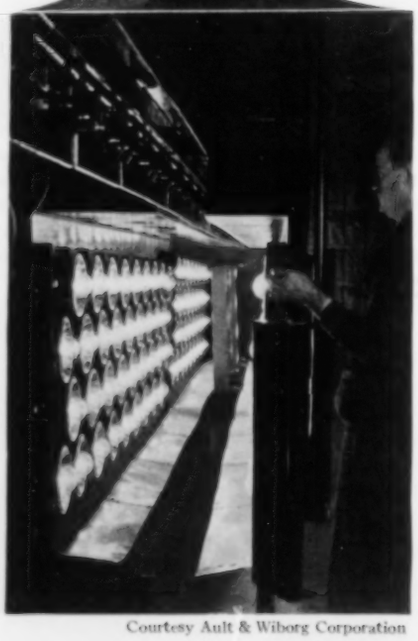
Courtesy Wabash Appliance Corporation

INFRARED LAMPS

The two clear lamps are used in connection with either gold-plated or aluminum reflectors, while the one in the foreground is a new bulb of the Birdseye type and is a combination heat unit and reflector. It is lined with pure silver and is protected by an air-tight seal against oxidation and the infiltration of dust and fumes. Where the ordinary incandescent lamp is made to give the greatest possible percentage of light in the visible range, these special lamps are designed to do just the reverse. They operate at much lower temperatures and develop infrared energy at wave lengths possessing high powers of penetration.



Courtesy Link-Belt Company



Courtesy Ault & Wiborg Corporation

DIFFERENT APPLICATIONS

The arrangements of the infrared lights are as varied as the products treated. At the left we see a double bank of lamps, numbering 144 units, baking the finish on part of a file case being carried through the "oven" by an overhead conveyor. It is installed in the plant of the Steel Storage File Company. Above is a section of the finishing department of the Fluid Oil Burner Division of the Anchor Post Fence Company, showing one of the infrared heating units in use there. It operates in connection with a spray booth where panels for furnaces are coated. The drier is made up of 96 infrared lamps and straddles a 25-foot-long conveyor for a distance of 11 feet. Traveling 1 foot a minute, the work reaches the discharge end cool enough to handle.

ANYONE who keeps abreast of new developments in the equipment field may have been struck by the frequency with which infrared lamps have lately been mentioned in trade and technical magazines. Most of us associate them with doctors' offices where individual lamps are used to bake aching joints; but today they are to be found in batteries, ranging from a few to many bulbs, in a wide variety of manufacturing establishments where the operations involve the drying or baking of paints, lacquers, enamels, etc. The application of infrared light to this class of work was originated by the Ford Motor Company and was, to quote the latter, "born of necessity."

In the early days of the automobile industry, the cars were finished with oleoresinous varnishes. They were not satisfactory because they took days to put on and soon showed signs of wear. Nitrocellulose lacquers followed. They were an improvement in that they could be applied in hours instead of days, and surfaces so finished could be depended upon not to lose that new look for some months, at least. The search for something that would have a much longer life under service conditions continued, and it was found in synthetic resin enamel of the alkyd type. This high-luster finish possesses another advantage over those mentioned in that it can be put on so smoothly that it is not necessary to sand and polish the final coat. However, where lacquers dry by evaporation of the solvent (air drying) and undergo no change the while, the enamel has to be baked on and changes both chemically and physically in the course of the process. Here was an obstacle that had to be overcome before it could be put to practical use in the automobile industry.

In the course of manufacture, finished bodies, especially, sometimes get scratched or are otherwise slightly marred. These imperfections have to be removed. In the case of lacquers, all that is required is to give the damaged area another coat. But to do a proper repair job with enamel, the part must again be passed through the drying oven, with the result that most of the finish is double baked while the fresh enamel is single baked. This produced a mottled effect and it was difficult to match colors, which are so popular today. The question was how to prevent overbaking either from the time or the temperature standpoint. Application of heat locally seemed to be the answer.

Without going into details, this was finally done successfully by means of infrared lamps. "At that time," to quote Mr. J. L. McCloud of the Ford Motor

Company, "it was customary to bake the finishes for one hour at 225°F., and if necessary we would have been glad to be able to repair mars in the same period. However, with these infrared carbon-filament lamps the time to bake was reduced by 90 per cent if the color was such that the radiator or electric light could be placed close to the surface. Obviously, we had the missing link to the program of employing synthetic resin enamel."

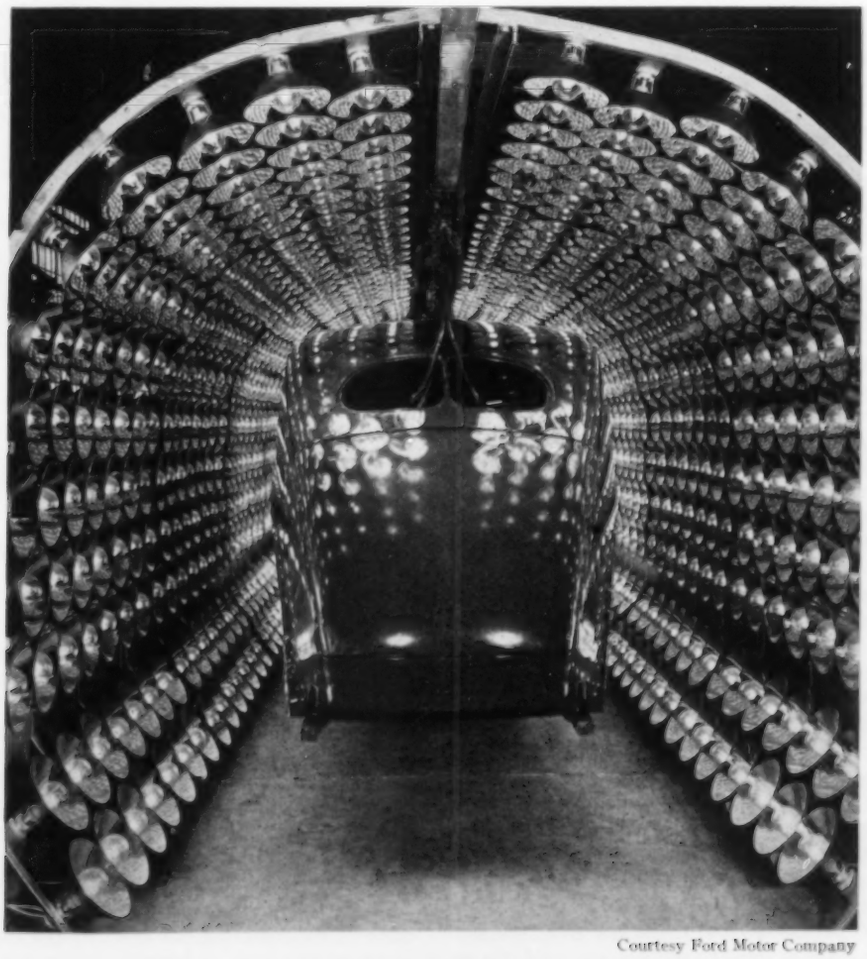
Of the different methods of applying heat, radiation has been found to be the best for the purpose, although induction heating is suitable for symmetrical objects that can be completely surrounded with coils. All electric bulbs give off infrared rays; but tests proved that where a carbon-filament lamp will heat a panel to 300°F. in a stated interval, a tungsten-filament lamp will bring it to a temperature of only 280°. As the rate at which energy is radiated is proportional to the difference in temperature between the radiator and the surface being heated, the more efficient the heating units the shorter the baking period.

Reflectors serve to intensify and to focus the light. The first ones were made of aluminum; but they were discarded when it was found that they soon became dull. Today, gold-plated reflectors are generally used because that metal is a good reflector in the infrared region, does not discolor nor lose its brilliance even in dusty atmospheres, and is not affected by the strong alkalies that are needed to remove the paint that is sometimes spattered on the reflectors from the nearby spray booths. Furthermore, the heat loss is inappreciable, in fact one can stand back of or alongside an "oven" of infrared lamps and feel no discomfort. This probably explains why the workmen call it "heatless heat." In addition to these advantages, the batteries of incandescent bulbs consume power only during the baking process, whereas it is necessary with conventional drying ovens to maintain heat not only during the operating period but also during the "stand-by" time.

Following the initial small-scale use of infrared lamps by F. J. Groven in 1932-33, the Ford Motor Company built a "light cave" large enough to accommodate an automobile body. The inner walls were covered with closely spaced lamps that completely surrounded the body when the doors of the oven were closed, leaving an intervening space varying from 12 to 18 inches. Subsequently, a series of mobile clamshell ovens was installed in the Rouge plant. Between the hinged sections of the clamshell ran a conveyor on which bodies ready for baking were hung, and as one entered a drying unit the halves closed about it and moved along with it until the predetermined baking period had elapsed. This type had one drawback: the entire system had to be reconstructed with each change in automobile style or length. Today, myriads of infrared lamps are arranged in the form of a tunnel and serve to bake oleoresinous prime coats on bodies, doing the work in eleven minutes at a temperature of more than 250°F., as contrasted with one hour by the old method. It is not used in the case of the final enamel coat because car bodies are not symmetrical and many colors are susceptible to temperature differences. This does not apply to smaller and symmetrical parts such as steering-post columns, wheels, etc. The oven for the former is connected to the spray booth, and the conveyor which carries the coated columns through them is equipped with holders that turn them continually, the rate of rotation being slowed down when the banks of infrared lamps are reached. It takes but three minutes to do the job, as against one hour with the former oil-fired ovens. Wheels, and steering wheels are sent through long tubes that are studded with lights and in which, because of multiple reflection, the hub is heated as fast as the rim.

So far we have dealt only with metal objects; but rubber, wood, plastic, and even paper as it comes from printing presses can be similarly treated. Ford steering wheels, for example, are made of rubber with a steel core and are given a high-luster finish of special enamel that is baked in less than twelve minutes under the action of infrared light. It used to take two hours to do the work. This great reduction in time is attributable to the fact that infrared rays penetrate the prime or finish and heat the underlying material, thus really drying from the inside out.

It is the phenomenal speed with which this baking process operates that is responsible for its introduction in a wide variety of plants making everything from novelties and buttons to large products, of which the automobile is a striking example. The baking units of course differ with the size and shape of the commodity, and, according to Mr. McCloud, "There are no special requirements for coatings to be used with infrared baking. Any paint whose drying is accelerated by heat may be dried in infrared light."

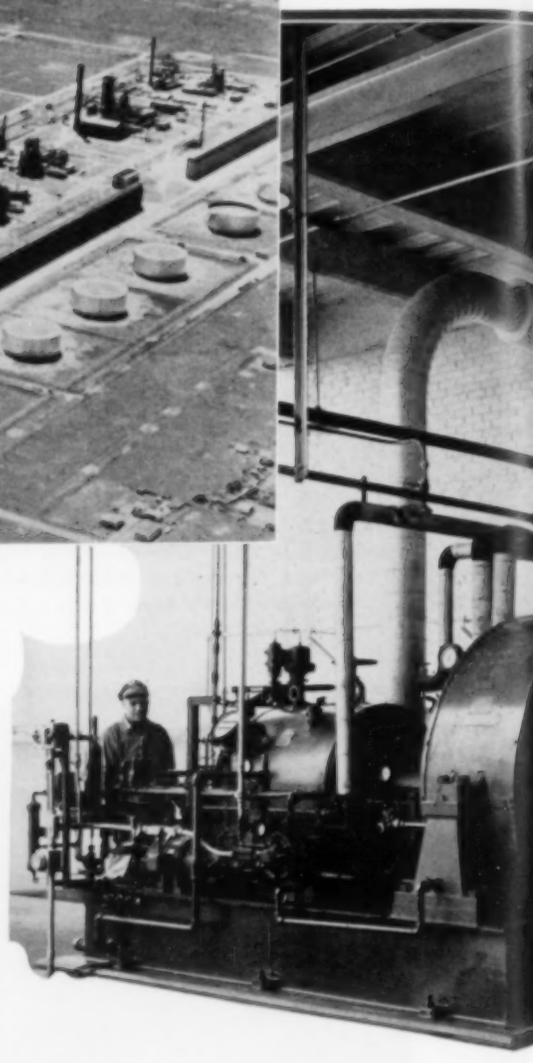


Courtesy Ford Motor Company

HEATLESS HEAT

These myriads of infrared lamps—6,048 to be exact—bake the prime coat on an automobile body in eleven minutes, and yet a person exposed to the rays feels no heat unless carrying metal. The latter, by interrupting the electromagnetic flow set up by 3-phase current fed into coils of wire by high-frequency generators, is heated by induction. The tunnel is 126 feet long and 10 feet wide, and automatic switches do not turn on the lights until the body is inside the baking oven.

We are indebted to the Ford Motor Company for the facts contained in this article.



TEXAS CITY REFINERY

This plant of the Pan American Refining Corporation includes the first commercial hydroforming unit, which is shown near the upper right-hand edge of the picture. All the low-octane heavy naphtha from two 40,000-barrel cracking units and from miscellaneous topping operations is converted to high-octane gasoline.

Reforming the

D. J. Smith and*

WHILE the use of catalysts to promote chemical reactions dates back almost to the beginning of chemical knowledge, it is only in the past five years that catalytic-petroleum-refining processes have found wide commercial application in the United States. The most recent addition to this growing family is the hydroforming process, so named because it is a catalytic process for "reforming" or converting low-octane to high-octane gasolines at high temperatures in the presence of hydrogen gas.

The first commercial hydroforming plant was placed in operation recently at the Texas City, Tex., refinery of the Pan American Refining Corporation. It is capable of reforming daily about 7,500 barrels of 40-45 octane heavy naphtha to an 80 per cent yield of about 80 octane ASTM gasoline. The unit is designed to take all the low-octane heavy naphtha produced by the two largest cracking units in the world (capacity about 40,000 barrels per stream day each), in addition to small amounts of heavy naphtha obtained from miscellaneous crude topping operations. The product from the Texas City plant will be blended into the principal grades of gasoline marketed by the American Oil Company.

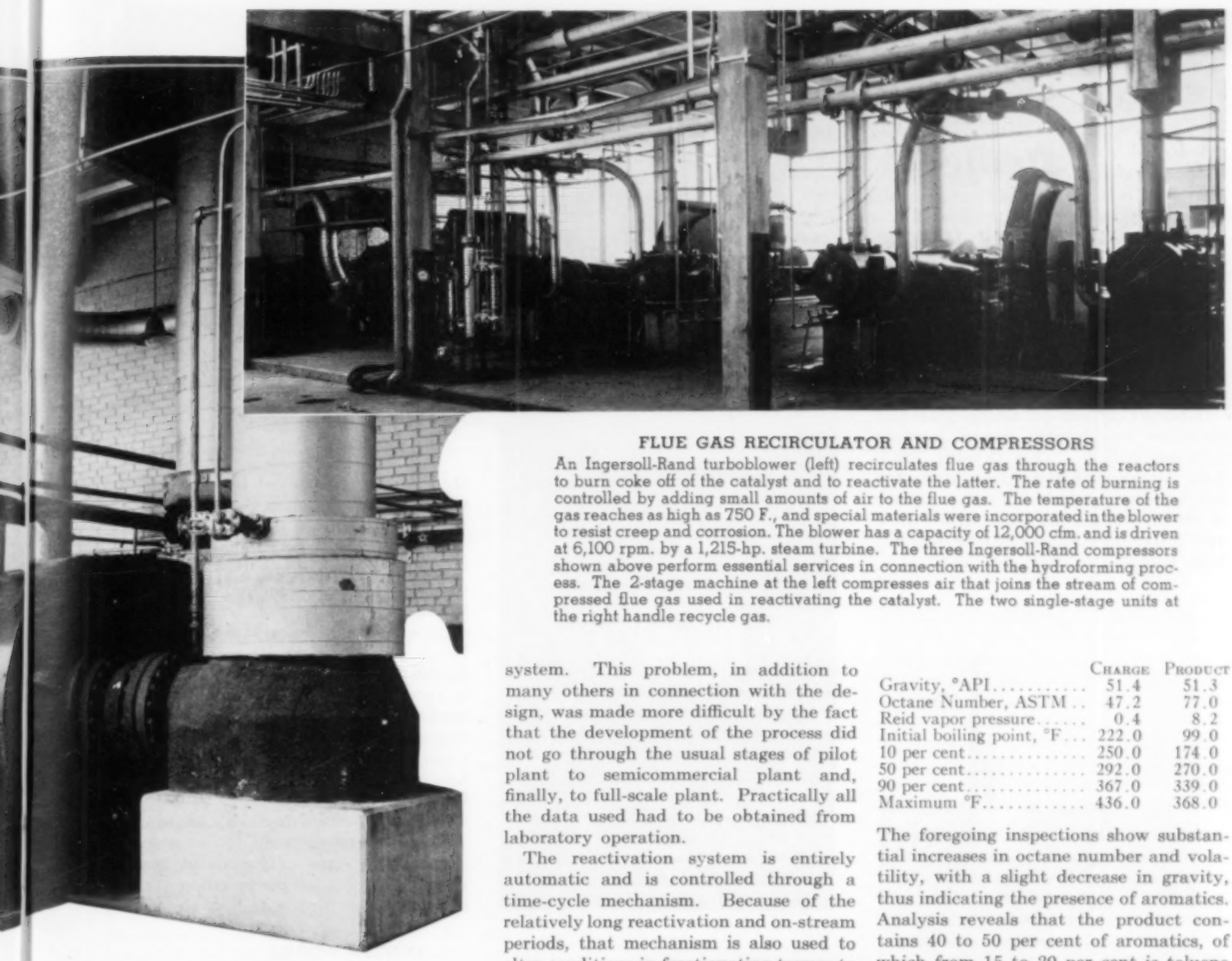
Because the hydroforming process necessitates carrying on a reaction in the presence of hydrogen, it might seem to be closely related to the hydrogenation process. This is not the case, however. Hydrogenation reactions involve the addition of hydrogen to hydrocarbon molecules, whereas the net effect on the hydroforming process is to dehydrogenate—that is, to take hydrogen away from hydrocarbon molecules. Part of the hydrogen thus produced is recirculated with the fresh feed to control the rate and extent of the dehydrogenation reaction. The most important property of the hydroforming catalyst is the one that causes ring-closure along with dehydrogenation, resulting in a yield that contains a high percentage of aromatic hydrocarbons and only a small quantity of aliphatic unsaturates. Consequently the product is unusually stable and, in the case of the Texas City plant, is blended directly into finished gasoline.

While the Texas City plant presented some difficult engineering problems, the process flow is relatively simple. The fresh feed, consisting of a 40-45 octane heavy naphtha, is preheated by heat exchange with hot reaction products and sent to a combination naphtha and recycle-gas preheater furnace. A hydrogen-rich recycle-gas stream from a gas separator also is preheated by heat exchange and passed through a separate coil in the preheater furnace which heats it to a high temperature. The two streams issuing from the furnace are then mixed and fed to the catalytic reactors which are under substantial pressure.

The hot reaction products leaving the catalytic reactors are partially cooled by heat exchange with cold-naphtha feed and other products. They are then cooled to normal temperature and sent to a gas separator. Part of the gas from the separator is used as recycle gas, and the remainder goes to the refinery fuel system. The liquid from the gas separator is pumped first to a stabilizer tower where the last traces of gas are extracted, and next to a rerun tower where a small amount of heavy polymer is removed. The product from the rerun tower is delivered to storage from which it is taken for blending into finished gasoline.

During the course of the hydroforming reaction a small quantity of coke is deposited on the catalyst. As the amount of coke increases, the activity of the catalyst gradually decreases, and it is necessary to remove a catalytic reactor from service periodically and burn off the coke in order to restore catalyst activity. Burning is done by recirculating flue gas through the reactors, the rate of burning being controlled by adding small quantities of air to the flue gas. Reactivation is carried out at an elevated pressure and at carefully controlled temperatures.

*Vice-president, Pan American Refining Corp.
**Technical Assistant, Pan American Refining Corp.



FLUE GAS RECIRCULATOR AND COMPRESSORS

An Ingersoll-Rand turboblower (left) recirculates flue gas through the reactors to burn coke off of the catalyst and to reactivate the latter. The rate of burning is controlled by adding small amounts of air to the flue gas. The temperature of the gas reaches as high as 750 F., and special materials were incorporated in the blower to resist creep and corrosion. The blower has a capacity of 12,000 cfm. and is driven at 6,100 rpm. by a 1,215-hp. steam turbine. The three Ingersoll-Rand compressors shown above perform essential services in connection with the hydroforming process. The 2-stage machine at the left compresses air that joins the stream of compressed flue gas used in reactivating the catalyst. The two single-stage units at the right handle recycle gas.

Gasoline Molecule

L. W. Moore[**]

The Texas City plant has two large catalytic reactors. These are in service alternately—one being on stream for reactivation and one off at all times. In laying out the plant care was taken to avoid thermal cracking of the naphtha before coming in contact with the catalyst because that would decrease both the yield and octane and result in excessive coke deposition.

The design of the recycle-gas-stream and reactivation systems was a complicated one from an economic standpoint because, for any given octane level, coke deposition is a function of the amount of recycle gas and of the hydrogen concentration of the recycle gas. Consequently, the size of the reactivation system is dependent on the size of the recycle-gas system. This problem, in addition to many others in connection with the design, was made more difficult by the fact that the development of the process did not go through the usual stages of pilot plant to semicommercial plant and, finally, to full-scale plant. Practically all the data used had to be obtained from laboratory operation.

The reactivation system is entirely automatic and is controlled through a time-cycle mechanism. Because of the relatively long reactivation and on-stream periods, that mechanism is also used to alter conditions in fractionating towers to take care of variations in product quality with changing catalyst activity. The hydroforming process as installed is a development of the research organizations of several companies, including primarily the M. W. Kellogg Company, The Standard Oil Development Company, and the Standard Oil Company (Indiana). The Texas City plant was designed by engineers of the M. W. Kellogg Company in collaboration with engineers of the Pan American Refining Corporation and the Standard Oil Company (Indiana). Construction work was done by the Kellogg Company. The unit is being operated under patent license from the Standard Catalytic Company which has important patent rights for this and related processes.

Although the hydroforming process is sufficiently flexible to produce gasolines over a wide range of octane numbers up to 90 ASTM, the conditions selected for the Texas City plant were those that would yield 80 per cent of an 80 ASTM octane gasoline. Typical charge and product inspections are as follows:

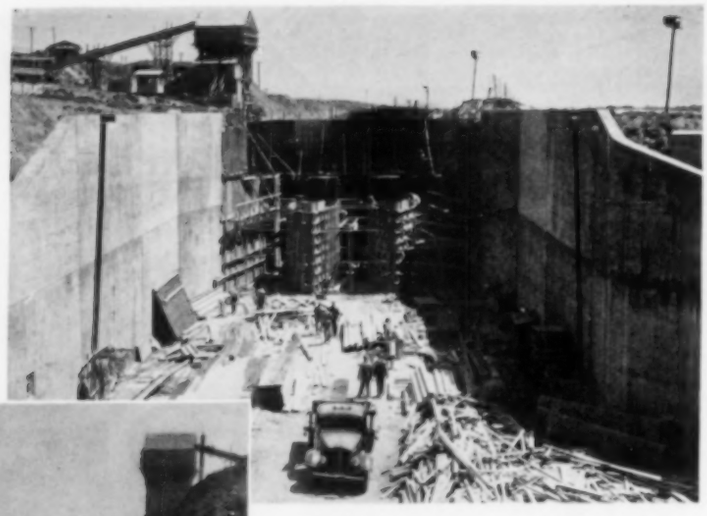
	Charge	Product
Gravity, °API	51.4	51.3
Octane Number, ASTM	47.2	77.0
Reid vapor pressure	0.4	8.2
Initial boiling point, °F	222.0	99.0
10 per cent	250.0	174.0
50 per cent	292.0	270.0
90 per cent	367.0	339.0
Maximum °F	436.0	368.0

The foregoing inspections show substantial increases in octane number and volatility, with a slight decrease in gravity, thus indicating the presence of aromatics. Analysis reveals that the product contains 40 to 50 per cent of aromatics, of which from 15 to 20 per cent is toluene while most of the remainder consists of xylenes and higher aromatics.

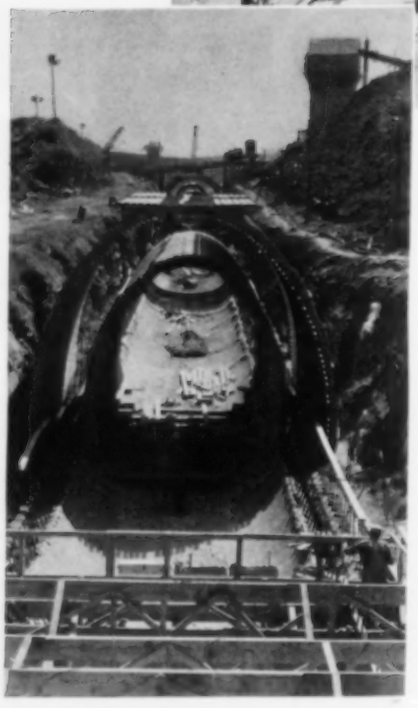
Although the principal application of the hydroforming process undoubtedly will be the production of high-octane motor-car gasolines, it is of a nature that will make it of importance to petroleum refiners in other directions. The process is sufficiently flexible so that either straight-run or cracked gasolines may be reformed; and, in general, the yield requires no treatment to render it suitable for the market. By changing operating conditions, the hydroforming process can produce a high-grade aviation gasoline, or it can be modified to give a product having upwards of 80 per cent aromatics. This latter phase of the process is particularly vital from a military standpoint, as it affords a means of substantially augmenting the country's toluene output. In 1939 the total yield of toluene in the United States was 20,000,000 gallons. The toluene content of the product from the Texas City plant alone is equivalent to 5,000,000 gallons annually.

Fort Supply Dam Project

Howard Wilson



EIGHTEEN years ago the North Canadian River in Oklahoma rose to flood stage, inundated streets in Oklahoma City, and did damage there and elsewhere that totaled several hundred thousand dollars. That October, 1923, flood was the worst of a series of latter-day rampages by the river and led to a study of the stream and its tributaries with a view to erecting suitable control structures. Near Fort Supply, Okla., on Wolf Creek, the Federal Government is now completing an $8,500,000 dam that is expected to aid materially in curbing excessively high water in the North Canadian.



The river angles across Oklahoma on a southeasterly course and enters the Arkansas near the eastern border of the state a few miles from Muskogee. The North Canadian has its source in the foothills of the New Mexico Rockies and is known as Beaver Creek in its upper reaches. Near Fort Supply, in northwestern Oklahoma, it is joined by Wolf Creek. The latter rises in the Texas Panhandle. Although it is only 85 miles long, it falls at an average rate of 10 feet per mile, and the runoff from its 1,473 square miles of watershed swells it far beyond its normal volume in periods of heavy rainfall. In 1923 the precipitation during six days, following a month of abnormal

OUTLET WORKS

Provision is being made for drawing down the reservoir level as desired by releasing water through gates. At the top is the channel on the upstream side of the dam leading to the discharge gates. The conduit extending from the latter to the downstream toe of the dam is shown above, at the left. The conduit will be 1,400 feet long and have a cross section of approximately 55 square feet.

EXCAVATING

In rocky areas of the spillway, excavating is being done by drilling with wagon drills. Air for this purpose and for operating various pneumatic tools is supplied by several late-model Ingersoll-Rand portable compressors. Blasted material is loaded by diesel-powered shovels into 15-cubic-yard Trac-Trucks.

rainfall, totaled 4.34 inches. At Fort Supply the flow of Wolf Creek reached a peak of 45,000 second-feet, and it was this sudden influx to the North Canadian that largely caused the latter stream to overflow its banks in Oklahoma City, 157 miles downstream.

Although general investigations were made, no definite action looking towards a correction of the situation was taken until 1936, when topographic surveys for a reservoir site were run and geological explorations of the proposed dam site were made with funds provided by the Federal Emergency Relief Administration. In the course of the following year engineering studies of a dam and spillway were undertaken; and upon approval of the flood-control project by the authorities in Washington operations were started in the spring of 1938 with the building of a camp to house workers.

The dam is located at a point 3 miles above the junction of Wolf Creek and the North Canadian River. It is an earth-fill structure 2¼ miles long and having a maximum height of 81½ feet. It includes a drainage system to give the structure, outlet works, and concrete spillway increased stability. The work was divided into three parts, each covered by a separate contract. The first of these included rough excavation of the spillway section and the placing of most of the earth fill; the second the construction of the outlet works; and the third, which is now in progress, the completion of the dam, placing of riprap, and erection of a gate tower for the outlet works.

The initial contract was awarded on October 3, 1938, to Morrison-Knudsen Company and W. C. Cole on a bid of $1,544,000, and was completed seven months ahead of the time limit set. It involved the placing of approximately 3,288,000 cubic yards of fill, of which 2,350,000 cubic yards was taken from the spillway excavation and 938,000 cubic yards from borrow areas. Different kinds of material were used. The section of the dam upstream from the axis is of earth that is classed as impervious, and a thin horizontal layer of the same material extends to the drainage system incorporated in the structure. It is composed largely of poorly consolidated sandy and clayey silt and silty clays. The center of the dam is a composite section of pervious and impervious, rolled random material. The downstream section is made up of pervious material. In placing the fill, the general procedure was to dump, spread, and wet it, and then to compact each layer eight times with sheep's-foot rollers exerting a pressure of 500 pounds per square inch of tamping foot.

The drainage system runs lengthwise of the dam base in the pervious downstream section and is designed to prevent weakening of the internal structure by percolating water and also to eliminate seepage at the downstream toe. It consists of a continuous, perforated, bitumen-coated, corrugated metal pipe laid in a trench and embedded in four courses of filter materials composed of fine sand, coarse sand, gravel, and rock. The pipe ranges in diameter from 21 inches at the eastern end of the dam to 42 inches at its outlet, where it discharges into a conduit stilling basin.

The second contract, covering the outlet works and amounting to $586,000, was carried out by the Uvalde Construction Company and the Keliher Construction Company between December, 1939, and the summer of 1940. The outlet is benched into the slope of the left abutment of the dam. On the upstream side an intake channel leads to the entrance of the gate passages. Then comes the gate structure with its operating machinery. Downstream from the gates, in the order given, are a transitory section connecting the gate passages with the conduit proper, an egg-shaped conduit 1,400 feet long and having a cross section equal to the area of a circle 17.7 feet in diameter, and a stilling basin with a flared apron, two rows of stepped baffle piers, and a continuous stepped end sill.

The third contract, which is now underway and which is scheduled to be completed before the end of the year, was awarded to Leo Sanders, of Oklahoma City, who is perhaps Oklahoma's foremost contractor in the dam-construction field. It amounts to $2,920,000. His forces are engaged in building a concrete weir-type spillway, setting the gates in the outlet works, filling in the gap between the dam and the spillway, and in placing riprap on both the upstream and downstream slopes of the earth-fill structure. It is being built up approximately 2 feet thick by laying 18-inch stones on a blanket of gravel and crushed rock. This will serve to protect the lake area against wave action and sloughing and the exposed face against erosion by wind and rain.

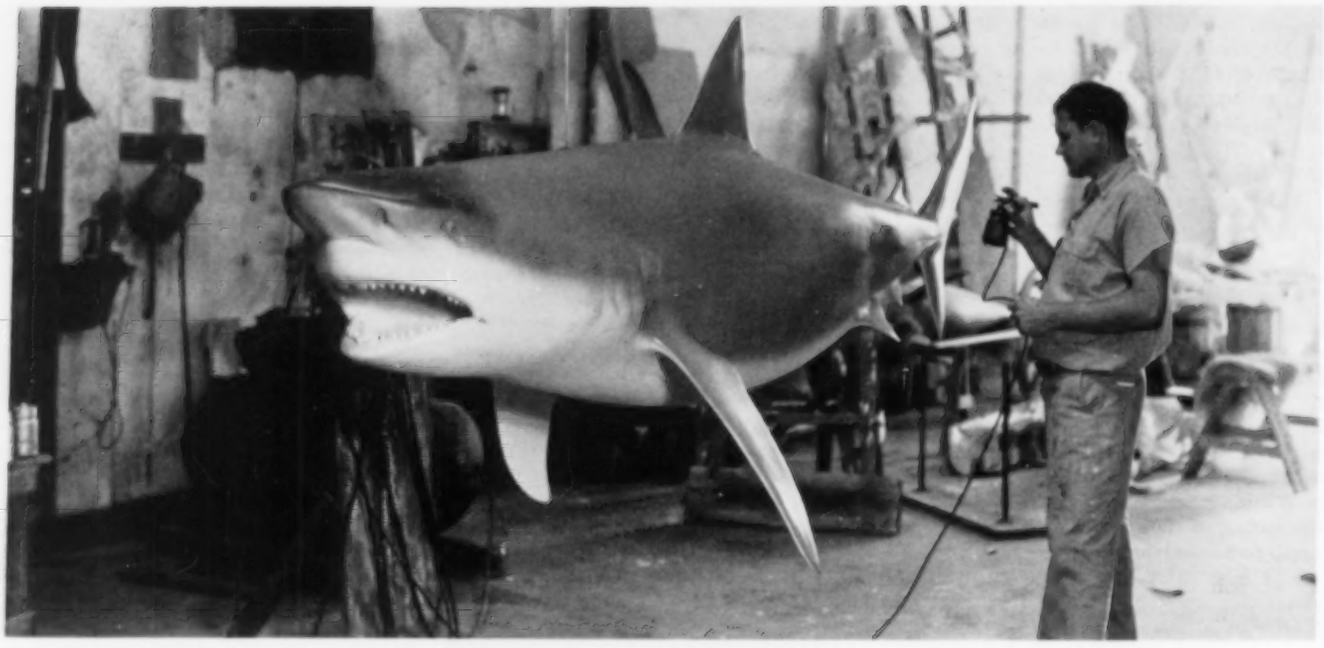
DRAINAGE PIPE

A section of the pipe that runs lengthwise of the dam downstream from the axis to collect percolating water and to lead it to the outlet conduit.

The concrete spillway is of the chute type and will provide means for the discharge of overflow water around the left end of the dam to the valley below. It is to be 800 feet long and 540 feet wide, and will have a control weir of concrete at its upper end and a stilling basin at its lower end. Excavating of the spillway foundation involves considerable rock drilling, with conglomerate one of the predominating materials to be removed. This is being done with X-71 drills on wagon mountings, efforts to put in horizontal holes having proved unsuccessful. Compressed air for operating the machines is supplied by three Ingersoll-Rand Mobilair portable compressors, two Model 315's and one K-500. The rock encountered is spotty, and numerous large boulders and clay seams add to the drilling and blasting problem. Hercules explosives are being used. The broken rock is loaded by Bucyrus-Erie 2½-cubic-yard diesel-powered shovels at the rate of 300 cubic yards an hour into Euclid Trac-Trucks having a capacity of 15 cubic yards. The material devoid of rock is largely clay and is being excavated with Gar Wood scrapers drawn by Allis Chalmers tractors. Keys and trenches are cut with pneumatic saws, and subgrading is finished with air-driven paving breakers and chisels.

The contract calls for the placing of more than 100,000 cubic yards of concrete. Aggregates are being transported by railroad from the Dolese stone quarries and from the Jackson-Squires sand and gravel plant at Camargo, Okla. The contents of the cars are automatically dumped into track hoppers from which the materials are moved by radial belt conveyors to stock piles. Beneath the latter are tunnels from which the aggregates are fed on to conveyors that transport them to the concrete batching plant as required. There they are proportioned by a Johnson automatic plant with a capacity of 100 cubic yards an hour and discharged into trucks that haul them to Rex and Ransome paver mixers stationed at the placement sites. The concrete is poured into Blaw-Knox forms, is vibrated pneumatically, and finished with Blaw-Knox equipment. Backfill placed behind finished spillway walls is tamped with I-R tampers and pavement breakers. All the air-operated tools are furnished with air from Model 210 I-R portable compressors.

When filled, the reservoir will impound 102,000 acre-feet of water and will cover approximately 6,500 acres. No towns, highways, railroads, or valuable lands will be inundated. It is expected that the lake will become a recreation area and a wildlife preserve. The work is known as the Fort Supply Project and is being carried out under the supervision of the U. S. Engineer office at Tulsa, Okla., in charge of Maj. H. A. Montgomery, district engineer. F. M. Newell is resident engineer.



PAINTING A BLACK-TIP SHARK

Al Pflueger shown manipulating an air brush in his marine taxidermy shop in Miami, Fla. The specimen is suspended by a wire. By mastering the technique of painting with spray guns Pflueger has become a world leader in his line.

Air Brush Revives Marine Taxidermy

EVER SINCE marine taxidermists began mounting game fish such as marlin, dolphin, tuna, tarpon, and sailfish, the task of painting the specimens with hand brushes has been a particularly onerous one. Efforts to duplicate coloring so that the mount would appear realistic and typical of its species oftimes failed. In addition, the method was cumbersome. Because of the unsatisfactory results obtained, many anglers gave up trying to preserve their catches as trophies. Then, along came the air brush, and marine taxidermy snapped out of the doldrums and became a thriving business.

Much of the credit for this revival is due to Al Pflueger of Miami, Fla., for it was he who applied air-brush painting to this field of work and developed it to such a point that he became a leader in the industry. A skillful fisherman himself, Mr. Pflueger owns and operates what is said to be the largest fish-mounting establishment in the world and employs a staff of assistants who prepare, mount, repair, and paint some 3,500 large game fish annually. In fifteen years more than 20,000 specimens of some 525 varieties have passed through his shop. They have been shipped to every country where ocean fishing for sport is practiced. Fish skins for mounting are received regularly from all parts of the globe. With only the skins, teeth, and tails of the denizens of the deep, Pflueger is able to make lifelike likenesses of them, thanks to the facility with which the coloring matter and protective lacquer can be applied by the air brush.

Mr. Pflueger has long been a student of fish coloration, and years ago reached the conclusion that marine taxidermy would not flourish until something better than the hand brush was available with which to do the painting. This prompted him to experiment with the air brush and to develop the technique that has brought him success. As all anglers know, deep-sea fishes change outwardly after capture. In fact, as soon as a fish strikes the lure its color-cell system undergoes a change that is analagous to the chill or profuse perspiration experienced by human beings following a severe shock or accident. The extent of the change varies. With a dolphin, for example, it is so pronounced that a specimen takes on a markedly different aspect during the time that it is being hooked, brought to gaff, and landed on the deck of a boat.

In order to obtain authentic color charts of fish as they appear in their native habitat, Mr. Pflueger made many fishing trips, some of them to points at considerable distances from Florida. He took with him artists to record the colors of the fish as soon as they were caught. These expeditions are still made, and several times a year the men also visit Bimini where they study fish through glass-bottomed boats with the aid of water spyglasses such as sponge fishermen employ. As a result of these researches, Pflueger possesses 450 technically accurate color plates of as many species of fish. These serve as guides in applying the colors.

When the skin of a dolphin, tuna, or other game fish has been tanned and mounted, the next stage is the paint department. The delivery hose from the air compressor with which it is equipped has half a dozen branch lines, each of which terminates in an air brush. Paints of various hues are placed in screw-cap jars that can be attached to any of the brushes, making it possible to change readily from one to another. Quick-drying lacquers are employed almost exclusively for this work. The basic coat is usually white or silver, and on this are laid the infinite variety of colors that give the specimen verisimilitude. Here the skill of the artist comes into play, and Mr. Pflueger and his assistants have acquired delicate control of the air-brush trigger that enables them to obtain the desired effects. The color plates previously mentioned are available for reference, and with these as guides no difficulty is experienced in making even the rarest fish look natural.

Following the painting operation, the specimen is given a coating of protective varnish, which is likewise applied with a spray gun. It is then hung in a dust-free drying room, where the varnish dries in from six to eight hours. As an extra precaution it is retained for two or three more days, by which time the protective film has thoroughly set. The mount is then crated and shipped to the customer. The excellence of the work done in the Pflueger shop is attested to by the fact that angling enthusiasts have often paid as much as $350 for the mounting of a single specimen.

Carlton Tunnel Completed

THE Carlton Tunnel, a drainage bore that promises to extend the productive lives of Cripple Creek, Colo., gold mines by fifteen or twenty years, was officially completed on July 25, an event that was informally celebrated by the workmen. Actually, the tunnel heading is now some 250 feet beyond the initial goal—a point underneath the bottom of the Portland No. 2 Shaft. It was continued in the hope of striking a watercourse that would speed the draining of the Portland. Apparently, this effort was not wholly successful; but as water is issuing from the bore at the rate of 7,500 gpm., the eventual drainage of the Portland and of all other principal mines in the area is assured. Meanwhile, in an endeavor to increase the flow and to expedite unwatering, small crews will probe faults that have been cut through. It is possible, also, that the projected laterals to the Cresson and Vindicator mines will be driven, but this work will probably be done piecemeal.

As has been recounted several times in this publication, the Carlton Tunnel stands as a monument to speedy boring through rock. When the Golden Cycle Corporation appropriated $1,000,000 to carry on the work, it was believed that four years would be required to complete the 6 miles of main tunnel to the Portland No. 2 Shaft. Upon assuming the job of superintendent, John R. Austin asked the management if 30 feet of progress daily would be satisfactory, and was assured that it would exceed the most optimistic expectations. He then asked if the Golden Cycle Corporation would be willing to pay a bonus to the drilling crews for every foot of daily advance in excess of 30 feet, and there was no hesitation in giving him an affirmative reply. So it was agreed that the tunnelers should get $5 for every foot driven over and above the daily quota, figured on a monthly basis.

The first 28,970 feet to the New Market Fault was excavated at a daily rate of 51.09 feet. The heavy flow of water struck there impeded progress; but final figures for the 6 miles show a daily advance of 48½ feet, or, roughly, 60 per cent in excess of the basic rate set, and 180,000 cubic yards of Pike's Peak granite drilled, blasted, loaded, and transported. The muck trains made 5,798 trips from the heading to the dump, hauling a total of 60,000 cars each carrying a load of 3 tons. To break the rock, more than 240 miles of blast holes were drilled and charged with more than 100,000 pounds of powder.

The tunnel will give the various mines from 225 feet to around 1,100 feet of additional vertical working depth without the expense of pumping water, which has for several years past cut deeply into their profits. Cripple Creek doesn't expect a wild boom; but it does look forward to many more years of steady production. Before full advantage can be taken of the tunnel, shafts will have to be deepened, hoisting machinery replaced or augmented, and numerous other necessary operations carried out. All this will cost around $1,000,000. So, in the end, the Golden Cycle will in effect have wagered $2,000,000 on the future of Cripple Creek.

Our Oil Reserves

THOSE who like to consider the welfare of our continent from a long-range viewpoint no doubt find comfort in the knowledge that we are assured a supply of gasoline for hundreds of years to come. Not only do we have enormous reserves of petroleum in the ground; but geologists tell us that there is no question about their ability, with modern geophysical methods, to locate deposits not now known.

Our reserves go far beyond that point, however. The U. S. Bureau of Mines reports that enough oil to last us 3,000 years at our present rate of consumption could be made from our 3,000,000,000,000 tons of coal reserves. A hydrogenation process for this purpose has been worked out and has been successfully tested on coals from thirteen different sources. Based on the data assembled, it is estimated that these coal reserves would yield 3,800,000,000,000 barrels of oil. The cost of producing the oil has not been determined; but, with the equipment now available, it is known to be considerably greater than the present cost of obtaining crude oil from the ground. Accordingly, production on a commercial scale cannot be expected for years to come, but in the meanwhile work is being continued in the hope of finding suitable extraction processes. In addition to the reserves of oil in coal, there are millions of tons of oil-bearing shales in several western states, and these constitute a huge potential source of oil. Here, again, enough experimental work has been done to make sure that extraction processes will be available if and when they are needed.

Our neighbor to the north, Canada, is likewise well supplied with reserves. Writing in *The Miner*, a Vancouver, B.C., publication, Max W. Ball, former Denver oil man, gives some startling facts regarding the bituminous sands of northern Alberta. "They constitute the world's largest known oil deposit," he states. Estimates made by authorized Dominion investigators place their oil content at from 100,000,000,000 to 500,000,000,000 barrels. Compare these figures with the estimated 35,000,000,000 barrels for all the proved oil-field reserves in the world.

The so-called tar sands of Alberta are from 100 to 200 feet thick, and their oil content ranges as high as 25 per cent. The oil does not fill the pores of the sand, but occurs as a film on each grain. To recover this oil the sand will have to be mined. Except in river valleys, it lies buried beneath from 500 to 1,800 feet of shale, sandstone, and glacial drift. As shafts, drifts, and other openings would have to be supported, the cost of underground mining would be prohibitive at prevailing petroleum prices; and it is very likely that, for a good many years to come, only those deposits that lend themselves to open-pit mining will be exploited.

Pinch of Resin in Cement Keeps Roads from Scaling

SCALING of cement highways as the result of alternate freezing and thawing has been aggravated in recent years through the application of chemical compounds for the removal of ice. Severe winter weather has meant scaled roads in spring, thus discounting the benefits derived from the use of calcium chlorides. Cement companies and maintenance engineers sought an answer to the problem; and it has been established that minute amounts of fat, oil, or oleoresinous materials will produce a cement possessing high scale resistance.

According to a recent announcement made by the Hercules Powder Company, adding as little as 0.03-0.05 per cent of Vinsol resin, a pine-wood derivative, to the clinker during grinding will virtually eliminate surface scale. This has been verified by comparative tests with standard portland cement, coarse-ground portland, portland plus natural cement mixed 6:1 by volume, portland plus 0.05 per cent fish-oil stearate, and portland plus 0.05 per cent Vinsol resin, both the latter ground in at the mill.

An experimental road was constructed and divided by dummy joints into 20-foot sections, two for each kind of concrete used. One of these was made with sand of good quality and the other with poor sand. The individual slabs could be flooded with water supplied by dikes built around the sections. After each freeze the ice was melted with calcium-chloride flakes, 2 pounds being applied per square yard of surface. After ten to fifteen thawing cycles the slabs of standard cement with inferior and good sand were scaled 80-98 and 34-75 per cent, respectively. The blend of portland and natural cement gave better results during the first winter; but the following season scaling progressed rapidly. The portland-fish oil stearate and portland-Vinsol slabs showed no signs of scaling the first winter, regardless of the sand in the mix; but at the end of the second winter, after 61 thawing cycles, scaling ranged from 0 to 8 per cent. Of the two ingredients, Vinsol resin is the more economical: it costs only a fraction of a cent per barrel of cement.

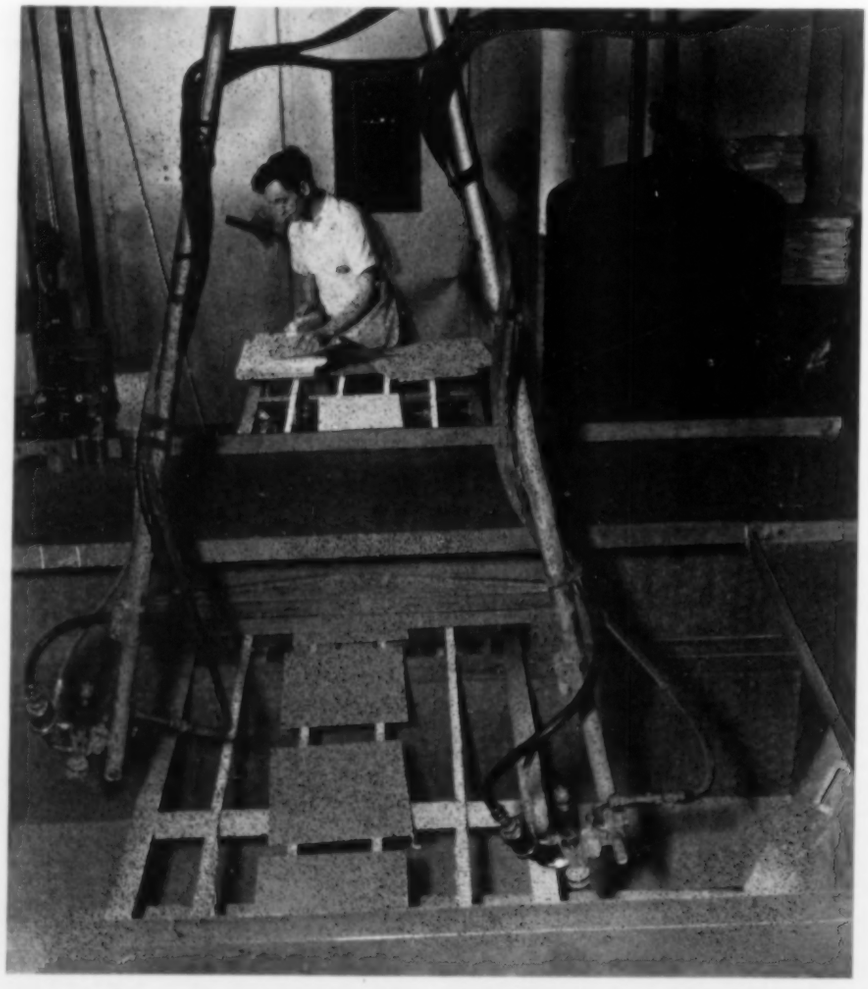
Contractors who have used the resin-treated cement in large-scale field tests claim that it is also more workable than ordinary blends. This permits a reduction in the water-cement ratio which, in turn, offsets the inappreciable loss in strength attributable to Vinsol. In addition, they report that there is noticeably less bleeding, pocket formation, and segregation of water, mortar, and aggregate, with the result that the finishing crews can follow immediately behind the mixing and placing crews.

Instrument Dials that Retain Whiteness in Service

WHITE instrument dials that stay white when exposed to light, moisture, high temperatures, and chemical fumes are being produced by the Westinghouse Electric & Manufacturing Company, according to a recent announcement. They are made of metal coated with a newly developed liquid plastic that is applied by two oscillating spray guns in a booth from which contaminating outside air is excluded by keeping it under a pressure of one- or two-tenths of a pound above atmospheric pressure. The compressed air admitted is filtered to remove entrained dust or other foreign matter. Immediately after spraying, the film is quickly surface hardened in an especially designed electric oven.

Printing also is done under carefully controlled atmospheric conditions. The dial faces are first laid out on a large scale by hand and then reduced to size by photographing them. As the plastic coat is hard when dry and well-nigh impervious to ink, the design is transferred to the sheets by a special lithographic press in an air-conditioned room. Guide marks are imprinted at the same time and, when subsequently punched out, permit each sheet to be accurately spotted on the blanking press. If the distance between the holes is not within 0.005 inch of the specified dimensions, the work does not pass inspection.

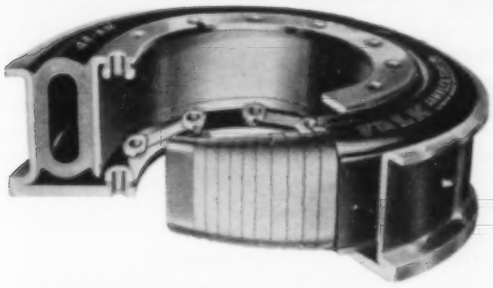
The new dials have been tested side by side with white lacquered ones and have, it is claimed, remained substantially unchanged where the latter turned a light coffee brown after ten hours' exposure to dry air at a temperature of 317°F., straw color after an exposure of 120 hours to fumes from heated raw phenolic plastics, and became mottled with yellow splotches after being exposed for 100 hours to a saturated sulphur dioxide atmosphere.



MAKING INSTRUMENT DIALS

The surface of the metal stock used is especially prepared to assure a firm bond between it and the white plastic coating. The sheets are carried by a traveling conveyor beneath the oscillating spray guns in the foreground and then directly into the heating tunnel. The man in the background is at the discharge end of the conveyor and is seen stacking the dried sheets. The room in which the lithographing is done is cleaned by a bank of electrostatic precipitators.

Resilient Coupling Protects Machinery from Shocks



UNDER a license from Thomas L. Fawick, The Falk Corporation is manufacturing a resilient coupling, called Airflex, that serves a dual purpose. It is designed to connect and at the same time to protect machinery from shocks resulting from irregular torque characteristics either of the prime mover (an electric motor or an oil, gasoline, or gas engine) or of the machine driven by it. There are several different types to meet varying requirements; but the damping feature that prevents the transfer of noise or destructive vibration from one machine to another is the same in each case. It is a pneumatic gland that is permanently bonded to an inner and outer steel rim and consists of an airtight cylindrical container of resilient rubber surrounded by multiple layers of durable fabric and live rubber. It is inflated with compressed air that is introduced through a special Schrader valve in the outer rim. Air at a pressure ranging from 25 to 125 pounds per square inch is used, depending upon service conditions, and simply by changing the pressure throughout that range it is possible to change the rigidity or cushioning effect of the coupling. The result of this control of high torque fluctuations is said to be less machine maintenance and longer active life. The Falk Corporation has recently published a bulletin, No. 8100, in which typical installations of Airflex couplings are illustrated and discussed and which contains tables to aid prospective users in making selections. It can be obtained by addressing the request on a company letterhead to 3001 West Canal Street, Milwaukee, Wis.

Electric Eye on Guard at Bessemer Converters

BESSEMER converters of the Jones and Laughlin Steel Corporation are equipped with a flame-control device that depends for its effectiveness on the photoelectric cell or, as it is popularly known, the electric eye. According to Dr. H. K. Work, who described the improvement at a recent meeting of the American Institute of Mechanical Engineers, an autographic record of the flame intensity is made for the entire blow, and filters are needed to absorb the heat rays and to take advantage of a selective range in the spectrum.

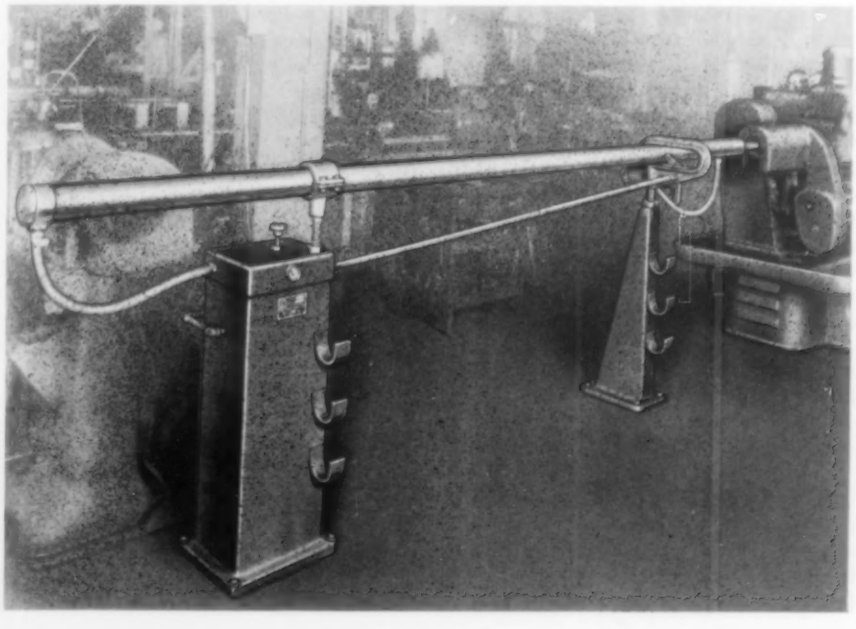
The photoelectric cell is used throughout the blow, but its greatest value is in detecting the beginning and end of the "after blow." The average length of the latter is 16 seconds, and its end must be determined within 2.5 seconds. If this period is exceeded, oxidation and absorption of nitrogen occur; the resultant product is characterized by increased aging, blue brittleness, and low-temperature brittleness; and the mill loss is high. But with the "sharp" electric eye on guard it is possible to keep within the prescribed limits and thus to cut down the mill loss to a marked extent. In addition, a considerable saving is effected in manganese because less is required for deoxidation.

New Peele's Handbook

MINING engineers the world over will welcome the publication of a new edition of *Mining Engineers' Handbook* edited by Prof. Robert Peele. Ever since it first appeared in 1918, it has been the standard reference work in its field. It was revised and improved in 1927, and now the third edition, much amplified, is available. The book is in two volumes, covers every phase of mining operations, and the material is arranged in sections for easy finding and reading. John A. Church has collaborated with Professor Peele on this new edition, and various competent authorities in different branches of the mining industry have served as associate editors. The result is a comprehensive, authentic work that leaves little to be desired. Published by John Wiley & Sons, the book can be obtained through this magazine. Price, $15.00.

Machine Feeds Bar Material Pneumatically

COLLARS, chucks, ratchets, rollers—in fact, all troublesome feed parts of turret lathes, screw and cutoff machines, etc., are dispensed with, it is claimed, by the use of a pneumatic bar feed developed by W. C. Lipe, Inc. It is designed for machine tools with fixed stops that determine the length of the work, and will feed stock any distance without surface contact. The unit consists of an air cylinder adjustably mounted on two steel standards and is sufficiently long to house a full-length stock bar the free end of which is prevented from whipping by the ball-bearing cup center of the piston. Compressed air at from 2 to 15 pounds pressure, depending upon the weight of the stock, is used and forces the piston forward the instant the collet is opened. Movement is rapid and the stock is held firmly against the stop until the collet is again closed. Feed power, however, can not be applied until the cylinder is locked in proper working position. When the piston reaches the end of the forward stroke, the air is automatically shut off. The unit is then reloaded and the new bar pushes what is left of the preceding one into the collet of the machine, a floating coupler tube serving to keep them in alignment. The Lipe pneumatic bar feed is available in three models handling stock of any length up to 12 feet and of any shape 1, 2, and 2½ inches in cross section, respectively. It is said to work without marring material and is applicable to other types of machines.



Industrial Notes

For coating the inner surfaces of boiler, economizer, condenser, and other accessible tubing, The Dampney Company of America has developed the pneumatic equipment shown in the accompanying illustration. It is used in connection with

Apexior, the company's own protective material that is said to prevent discoloration of the water and the formation of iron oxide. The outfit consists essentially of a pressure-feed container with an agitator operated by an air motor and of a rotary brush and air-turbine assembly at the end of a twin hose line up to 75 feet long. One hose supplies compressed air and the other the coating, which is discharged from a nozzle into the path of the brush. The latter is passed all the way through the tubing and does its work as it is being withdrawn, the rotary action imparted to the brush by the turbine causing it to expand and to do a thorough, even job. The present equipment is designed for tubing ranging from 2½ to 4 inches outside diameter but is being adapted for smaller and larger sizes. It is suitable for long horizontal, vertical, and bent tubing, and can be purchased or obtained upon a rental basis.

For industrial structures exposed to salt water or the corrosive action of fumes or chemicals, Porcelain Steel, Inc., has introduced an interlocking material named Por-Ce-Lok that is suitable for both side walls and roofing. It is a porcelain-enameled, corrugated steel sheet that receives its protective coating after fabrication so that all surfaces, including holes and edges, are well covered. Standard full- and half-size sheets, 24 and 12 inches wide, respectively, and in six lengths up to a maximum of 10 feet, are carried in stock, and special sizes within specific limits are made to order. The new product comes in blue, green, brown, and maroon on the outside and white on the inside to reflect light. It is readily cleaned by washing.

Round tin cans packed flat for transportation are saving valuable shipping space in Great Britain where they have been introduced. The cans are of the open-top variety with fitted lids which, together with the bottoms, are delivered to the user in separate boxes. The body part is flattened by gentle pressure so that the bends are sufficiently rounded to avoid sharp creases, and the seam is soldered ready for closing. At the packing plant it is restored to cylindrical form, flanged, and receives the bottom. This is done by three machines that are easy to operate and soon paid for by the savings in freight charges. The cans come in varying sizes ranging in capacity from 5 fluid ounces to 7 pounds. They require only one-fifth of the space occupied by made-up cans.

Three fire-fighting trains, each made up of an engine, a truck, and a passenger car for eight firemen, have been put in service in England by the Great Western Railway. They are stationed at strategic points with steam up day and night ready to be rushed to any part of the system.

The invention of a device for recovering lubricating oil from the bilge water of ships is reported from Stockholm, Sweden. It has undergone a four-months' test aboard three tugboats and is said to have effected savings in lubricating oil of 75 per cent. If the refiner does all that is claimed for it it will also largely prevent the pollution of harbors with oil from this source.

For emergency use, the Central New York Power Corporation has purchased a mobile substation consisting of a 3-phase, 1,000-kva. transformer, primary and secondary switching equipment, and a lightning arrester. It can be hauled at the rate of 40 miles an hour, and supplies customers with current until the regular service is restored. The unit is designed to transform power ranging from 11,000 to 44,000 volts to 230-4,600 volts.

Experience has proved that the service life of wooden patterns for foundry use can be greatly lengthened by protecting them with metal. This is easily applied by means of a spray gun. Before metallizing, the new wood is thoroughly cleaned with turpentine and then dressed down with sandpaper or steel wool. Two coats are put on: one of pure zinc 0.005-inch thick and another of aluminum or bronze 0.25-inch thick. The surface is sanded or buffed to final pattern dimensions. Care must be taken in spraying to hold the gun far enough away from the wood to prevent scorching.

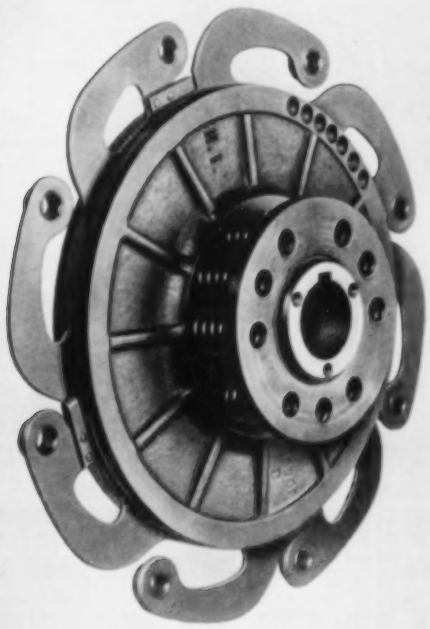
Reyn-o-cell is a cotton insulating material for homes that is said to be water-repellant, to withstand flame up to a temperature of 1,500°F., and to resist attack by rodents, vermin, fungi, and decay. It is supplied in blankets 16 to 24 inches wide and 1 to 3⅝ inches thick that can be cut to suit building requirements. It is also made with asphalt-impregnated paper backing or in combination with aluminum foil. For fastening to rafters, joists, and studs it comes in mounted form with flanges which hold the insulation in the center of the roof and wall construction and provide spaces for the circulation of air.

DuPont is offering a deactivating material for fuel oil and gasoline in storage. It is suitable for petroleum products containing soluble metallo-organic compounds and serves to counteract the catalytic effect of these contaminants. Based on current prices, it costs 0.1 to 0.5 cents to stabilize 42 gallons.

Too much stress cannot be placed on eye protection for foundrymen and welders who are exposed not only to the glare of visible light but also to the harmful invisible infrared and ultraviolet rays radiating from flames and molten metal. For such workers the scientist has developed absorptive glasses that depend on chemicals, not color, for their protective properties. One of these is said to prevent the penetration of 98 per cent and more of the invisible rays, while another is both chemically treated and hardened to resist the rays and the impact of flying particles.

The B. F. Goodrich Company has announced a new air hose of 2-braid construction that should appeal to shop men handling pneumatic tools. It combines light weight with strength, and is said to be so flexible that the ½-inch size can be bent to a 3-inch radius without collapsing or cutting off the air supply. According to the manufacturer, the tube is of oil-resistant rubber that does not flake; the

yarn reinforcement affords a safety factor of more than 5 to 1 under a working pressure of 125 pounds; and the golden ply insulation is of a special kind to minimize kinking. The hose is light gray in color to make it easily visible; and it is stocked in ½- and ¾-inch sizes. It is designed to withstand working pressures of from 80 to 125 pounds.



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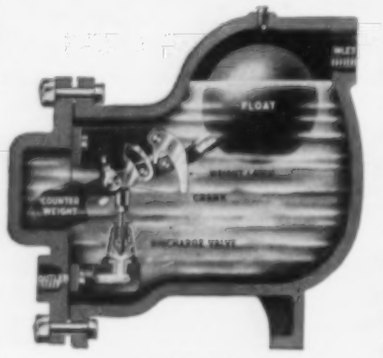

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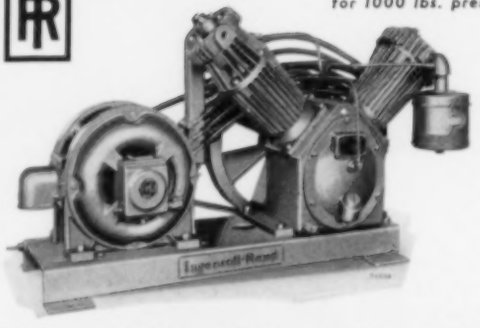

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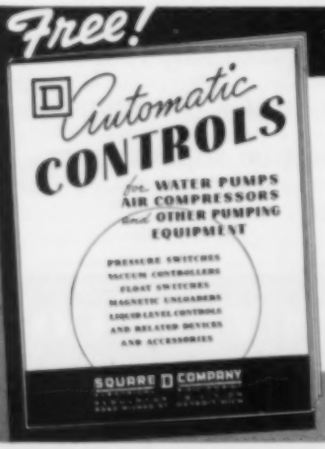

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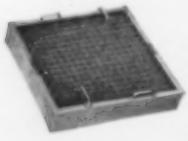

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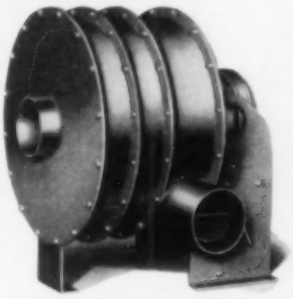

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Our shrouded impeller eliminates the necessity for close internal clearances which are expensive to maintain. Balanced rotors are carried on grease-packed ball bearings. Rolled steel casings and standard motors are used on all sizes.

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The Type "G" gives you full-rated pressure at full load, also practically constant pressure throughout the entire operating range. In addition, the power consumption decreases in almost direct proportion to any reduction in load.

Ingersoll-Rand
980-12 11 BROADWAY, NEW YORK, N. Y.

For Severe Leather Packing Service

Carefully selected raw leather, special tanning and proper treating give GARLOCK BITAN Leather Packings high tensile strength to withstand heavy pressures and make them resistant to temperature and acid or alkaline solutions. Proper tannage and treatment to suit the particular service are used in filling each order.

GARLOCK Leather Packings are manufactured in all types or forms for which leather commonly is used: Molded Cups, "U" and "V" Packings, Flange or Hat Packings, Washers, Gaskets and Discs. GARLOCK BITAN as well as GARLOCK Oak and Chrome Packings in all of these forms are produced in all commercially practicable sizes and for every service condition for which leather packings are suitable.

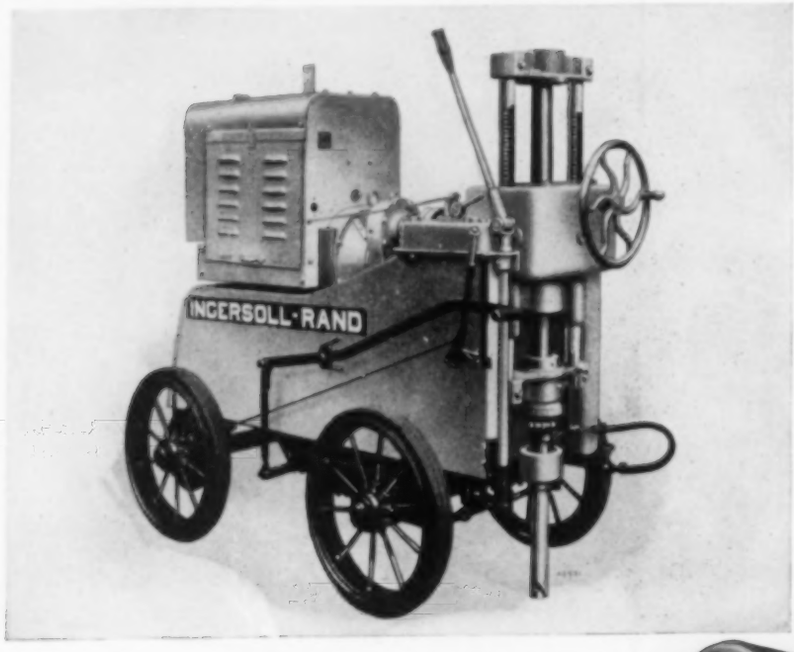
Write for descriptive folder!

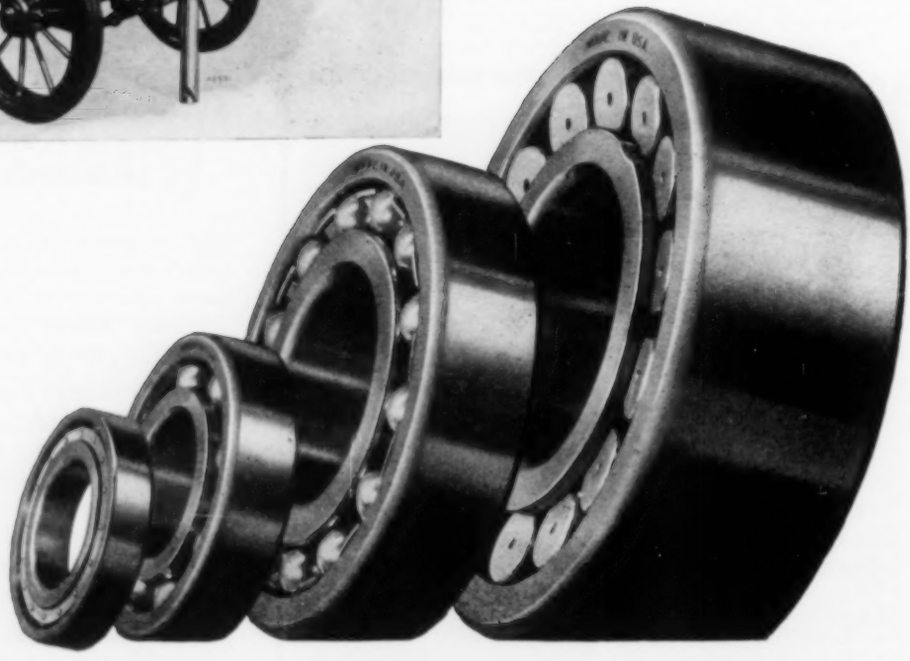
THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Limited, Montreal, Que.

GARLOCK
Bitan LEATHER PACKINGS

Defend your DRILLS *with* SKF





WE USE SKF BEARINGS

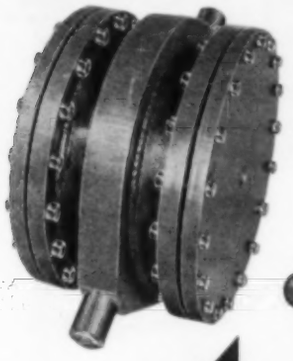
INGERSOLL-RAND CO.

You don't need to be from Missouri, where this traction-mounted Class PTM Calyx Drill works, to see one of these units in action. You'll find them wherever holes are drilled for electric light standards, safety zone standards, sample cores from concrete highways, etc. And you'll find SKF Bearings on the input shafts of forward and reverse transmission . . . on the spindle . . . where moving parts must be defended against bearing trouble. Putting bearings where they are needed most is a habit with SKF. 4848

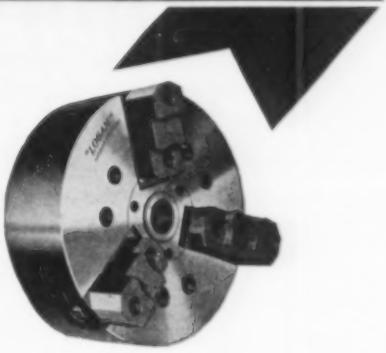
SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILA., PA.

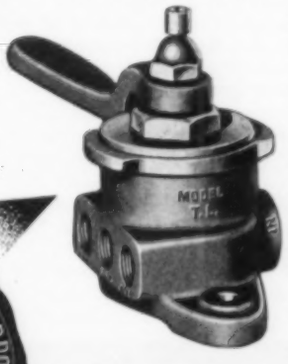
SKF
ball and roller
BEARINGS

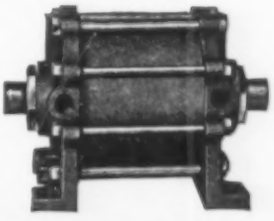
FOR 25 YEARS "LOGAN" Air Equipment Has Saved . . . TIME-EFFORT-MOTION



THIS YEAR marks "LOGAN'S" twenty-fifth anniversary. During those years "LOGAN" has solved production problems and speeded up manufacturing in most of the largest industrial plants in the world. And now in these days of great stress "LOGAN'S" entire resources and manpower are being devoted to the defense of America in her Armament Program. Let "LOGAN" Representatives and "LOGAN" Engineers make recommendations on your production problems.







LOGANSPORT MACHINE INCORPORATED 25 ANNIVERSARY LOGAN

LOGANSPORT MACHINE, INCORPORATED
920 PAYSON ROAD — LOGANSPORT, INDIANA
Manufacturers of Air and Hydraulic Devices, Chucks, Cylinders, Valves, Presses and Accessories

HEADQUARTERS for DIESEL BOOKS

1. DIESEL ENGINEERING HANDBOOK, Vol. I, is a book of more than a thousand pages and illustrations, covering such subjects as Diesel principles, fuel-injection systems, combustion systems, slow-speed Diesels, medium speed Diesels, high speed Diesels, engineering fundamentals and dozens of other vitally important subjects that we cannot list here. Bound in red leatherette, with red lettering on the cover, it sells for $6.00

Foreign and Canadian . . $7.00

2. DIESEL ENGINEERING HANDBOOK, Vol. II, just off the press, contains a mass of data not included in Volume I. Of special interest are the specifications of all American Diesels. $5.00

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3. Vols. I & II are offered at a combined price of $9.00

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4. DIESEL OPERATORS' GUIDE AND DATA BOOK gives detailed instructions in the operation and maintenance of twenty-seven different Diesel engines, with chapters on fuel systems, governors, erection, accessories, etc. This big book is bound in red leatherette and is priced at $6.00

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5. STANDARD PRACTICES prepared by the D.E.M.A. is written for operators, owners, prospective buyers, consulting engineers, Diesel salesmen who want a comprehensive guide book that includes the standard practices of the industry. A cloth-bound book; the price is only $2.00

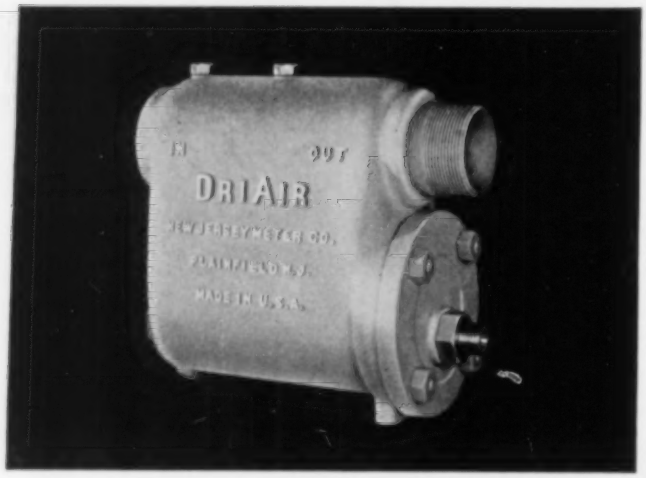
Foreign and Canadian . . $2.50

6. MARINE DIESEL ENGINE STANDARDS is a comprehensive handbook written for those particularly interested in the Marine Diesel engine. Bound in blue cloth with silver lettering, it is well worth its price of $2.00

Foreign and Canadian . . $2.50

ORDER from DIESEL POWER and TRANSPORTATION
192 Lexington Ave.
New York City, N. Y.

DEPENDABLE PNEUMATIC SERVICE



WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT

DriAir may be installed by suspending it from the piping without any other support.

A typical installation showing DriAir standing on the floor next to the wall.

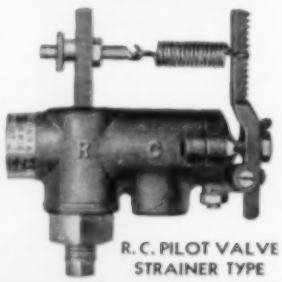
● The answer to many problems which arise in various applications of compressed air, DriAir speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request; write today.

NEW JERSEY METER COMPANY

PLAINFIELD, NEW JERSEY

R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



R. C. PILOT VALVE STRAINER TYPE

R. CONRADER CO.

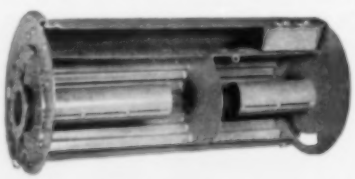
1207 FRENCH STREET · ERIE, PA.

PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

MAXIM

WASTE HEAT UNIT CONSERVES EXHAUST HEAT

Valuable exhaust heat can be turned to good use in making hot water or steam with one of the new Maxim Waste Heat Units. This unit combines efficient silencing, (and where desirable, positive spark arresting) with the conservation of waste heat.

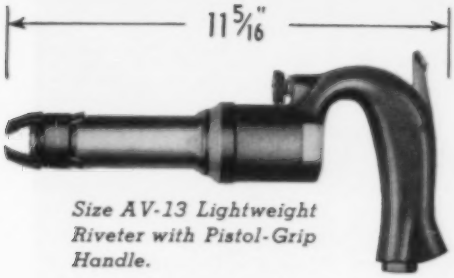


SEND COUPON FOR DETAILS

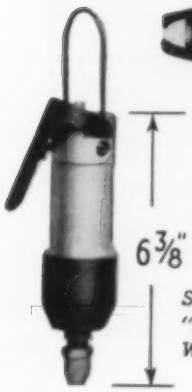
THE MAXIM SILENCER COMPANY
85 Homestead Ave., Hartford, Conn.
Please send details on your waste heat unit.
☐ for hot water ☐ for steam

Name .....
Company .....
Address .....
City ..... State .....

COMPRESSED AIR will Increase Production



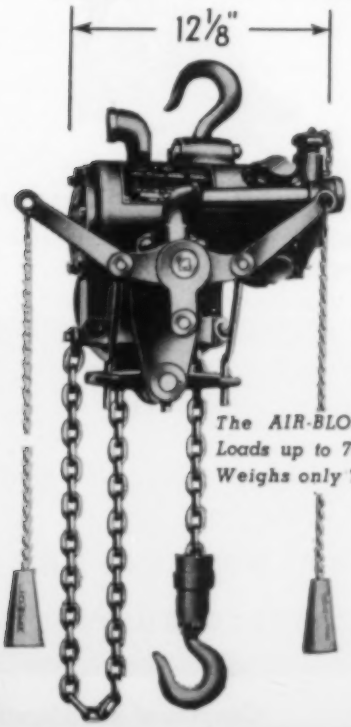
Size AV-13 Lightweight Riveter with Pistol-Grip Handle.



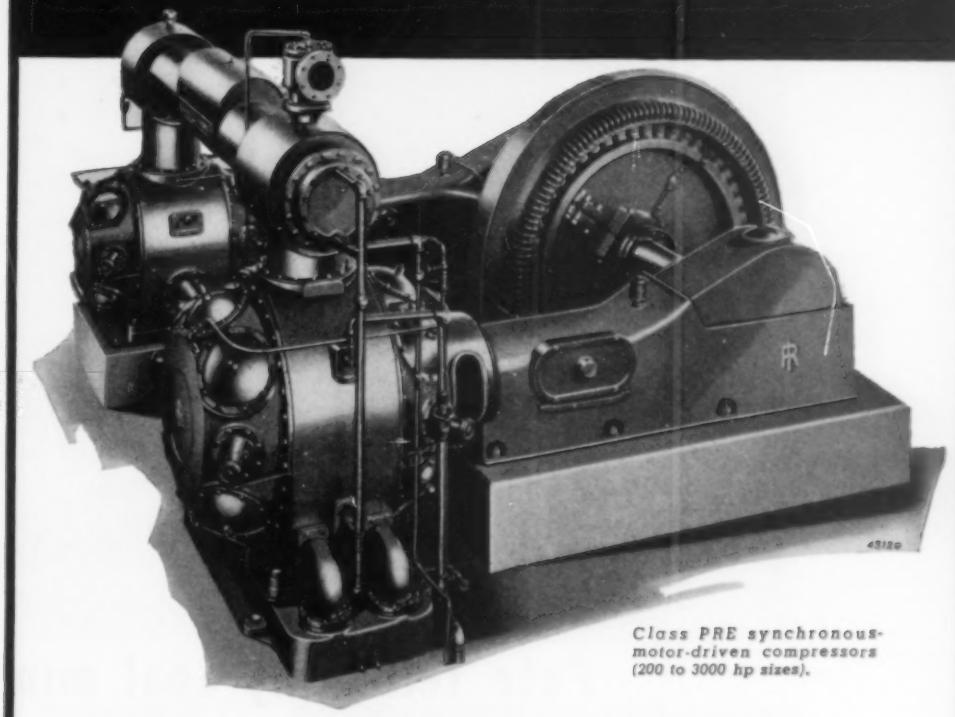
Size AV-11 Lightweight Riveter with Push-Button Throttle.

Size 00 Lightweight "Multi-Vane" Grinder. Weighs only 1¼ lbs.

Size 00L Lightweight "Multi-Vane" Drill with Pistol-Grip Handle.



The AIR-BLOC—for Loads up to 700 lbs. Weighs only 75 lbs.



Class PRE synchronous-motor-driven compressors (200 to 3000 hp sizes).

PLENTY of AIR POWER in your plant means increased production, and there are more than 350 types and sizes of air tools and 1000 sizes and types of compressors in the Ingersoll-Rand line.

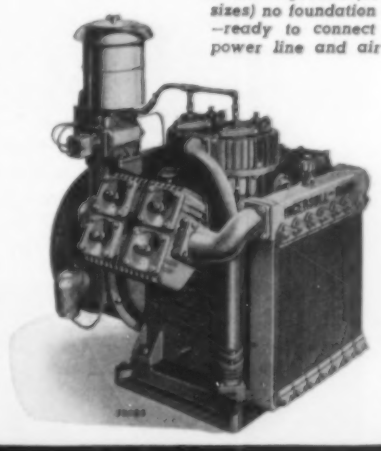
Ingersoll-Rand air tools designed particularly for aircraft builders include an extensive line of powerful and flexible riveters. Many sizes of light-weight drills are available with companion attachments for a multitude of jobs. New developments are the AIR-BLOC hoist and the 1¼-lb. Size 00 hand-held grinder which is a real multi-purpose tool with many applications.

It will pay you to choose an Ingersoll-Rand Channel-Valve compressor when you increase your AIR POWER plant. Whatever your needs, Ingersoll-Rand builds a standard machine to fit your job.

Write for your copy of Form 12,100, "Air Tools for All Purposes."

AIR TOOLS
for
Aircraft Builders

Riveters
Drills
Grinders
Industrial Hoists
Chipping Hammers
Wrenches
Nut Runners
Screw Drivers
Close-Quarter Drills
Sand Rammers
Core Breakers
Air Motors



The two-stage air-cooled Motorcompressor (15 to 90 hp sizes) no foundation required —ready to connect to your power line and air system.

14-1

Ingersoll-Rand

11 BROADWAY, NEW YORK, N. Y.

Pete tells why coal mining is better

"LOOKS like the country'll be needing all the coal we can get out for quite a spell. Kinda like old times. But we're sure getting it out in better shape than we used to. These new permissibles give us better lump.

"In the old days we shot a lot of fines. But Hercules service men soon showed us that permissibles could

shoot lump—or any size—if you get the right explosives for the job, and shoot 'em right.

"The Hercules people were the first to make permissibles with a lot more sticks in a box. Then they kept improving them. Seems like that high-count business gave Hercules the idea for working out powders, and ways of shooting, that will lay down the coal in any mine just the way you want it whether it's for machine or hand loading.

"And Hercules hasn't got so many permissibles that you can't keep track of 'em either. With Red H*, Hercoal*, and Hercogel*, you can shoot most coal to suit anyone. But if you run into something that's extra special difficult, why Hercules has a powder to take care of that, too.

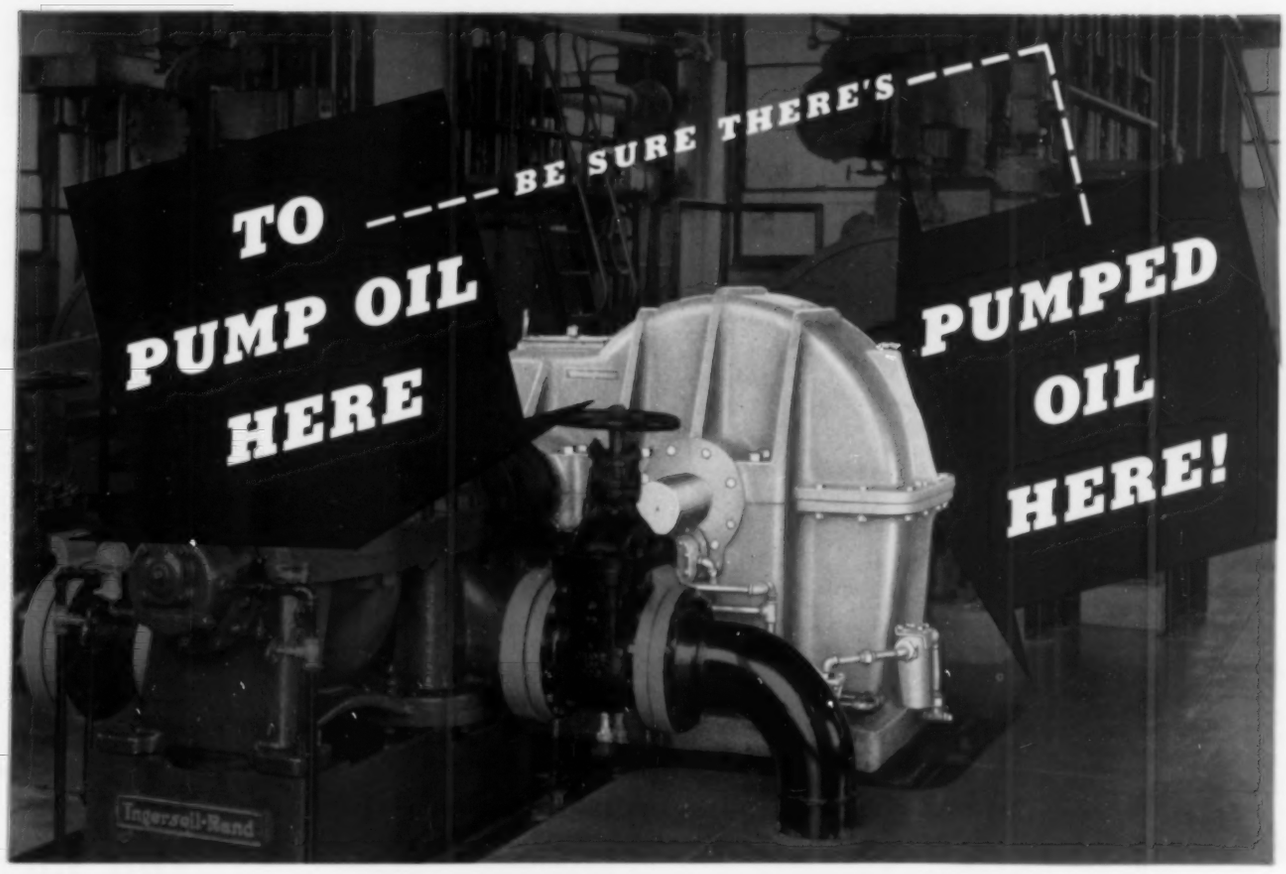
"I saw it figured out where these new powders that Hercules made first are saving the coal mines a million dollars a year on the cost of permissibles. And I wouldn't wonder a bit if that's right. They're improving their powders all the time, and the Hercules service men are always finding better ways to shoot the coal. No wonder the boss sticks to Hercules permissibles."

HERCULES POWDER COMPANY
INCORPORATED
932 KING STREET, WILMINGTON, DELAWARE
*Reg. U. S. Pat. Off., by Hercules Powder Co.

B-36

HERCULES

EXPLOSIVES AND BLASTING SUPPLIES

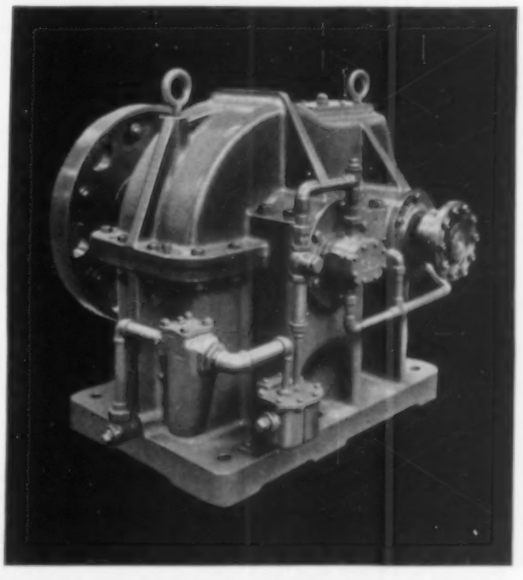


PRESSURE-LUBRICATED SPEED INCREASERS INSURE LONG-LIFE DRIVES

For oil to flow dependably through pipe lines, oil must flow dependably to the high-speed gears that drive the pumps. Westinghouse Speed Increasers insure quiet, continuous operation for pumps, compressors and similar equipment, because their lubrication is insured by positive pressure feed.

Oil pumped constantly against the mesh line of the gears prevents gears or bearings from ever running dry. All parts of the circulating lubrication system are externally mounted and easily accessible.

Westinghouse Speed Increasers are individually designed to exact requirements of prime mover and the machine they are to drive. They can be used to increase output speeds of Diesel engines, gas engines or electric motors. Write for booklet DD-3650 containing details and application data. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N.



Westinghouse Type SU-14-8 Speed Increaser showing forced-feed lubrication system with pump, cooler and strainer externally mounted.

J-07188

Westinghouse Geared Drives

They Don't Come Any Tougher!

GOODALL RUBBER CO. INC.

"MINE KING" Air Hose

For Hard Service in Long Lengths

A hose that gives supreme performance on the toughest mining operations will naturally find the going **easy** under less rigorous conditions. Goodall's new "White-Tite" friction holds the carcass intact under the roughest flexing. Tough brown cover. Black oil-resisting tube. Sizes: ½", Double and Triple Cord, and ¾", Triple Cord, max. lengths of 500 feet. 1", Triple Cord, max. lengths of 250 feet.

"SUBWAY" Air Hose

For Heavy Industrial Work

One large foundry had been buying 30,000 feet of air hose every year. Failure of the hose to stand the service caused frequent replacements and many injuries to the men. The foundry gave "SUBWAY" Brand a trial—then switched 100% to this husky, "Balanced-Built" hose. Their yearly air hose requirements dropped to 12,000 feet, and injuries became negligible. "SUBWAY" saved this company thousands of dollars a year. Find out what it will save you! Made in ½" to 1¼" sizes, max. lengths of 50 feet.

Send for Current Prices on Above Brands

GOODALL

RUBBER COMPANY INC.

10 SOUTH 36TH STREET · PHILADELPHIA, PA.

NEW YORK - BOSTON - TRENTON - PITTSBURGH - CHICAGO
LOS ANGELES - SAN FRANCISCO - SEATTLE
SALT LAKE CITY - HOUSTON

"MECHANICAL MUSCLES"

YOU CAN DEPEND ON

To Safeguard Machine Productivity

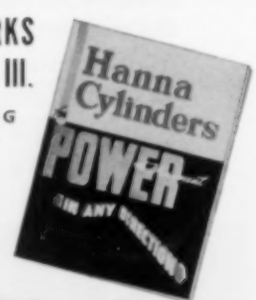
BY utilizing Hanna Cylinders as integral parts of the machines you design, you can be sure that performance and productivity will be safeguarded throughout the life of every unit. Here, then, are "mechanical muscles" built to perform the thousand and one jobs that you may require—raising, lowering, pushing, pulling—all with equal force, smoothness and speed and with a minimum of attention.

Hanna Cylinders have replaced manual effort in scores of operations—they have simplified all types of machine control and actuation. Results are continually demonstrating their economy. There is a standard Hanna Cylinder, air or hydraulic, for you application. Put them to work for you.

HANNA ENGINEERING WORKS
1765 Elston Ave, Chicago, Ill.

SEND FOR THIS NEW CATALOG

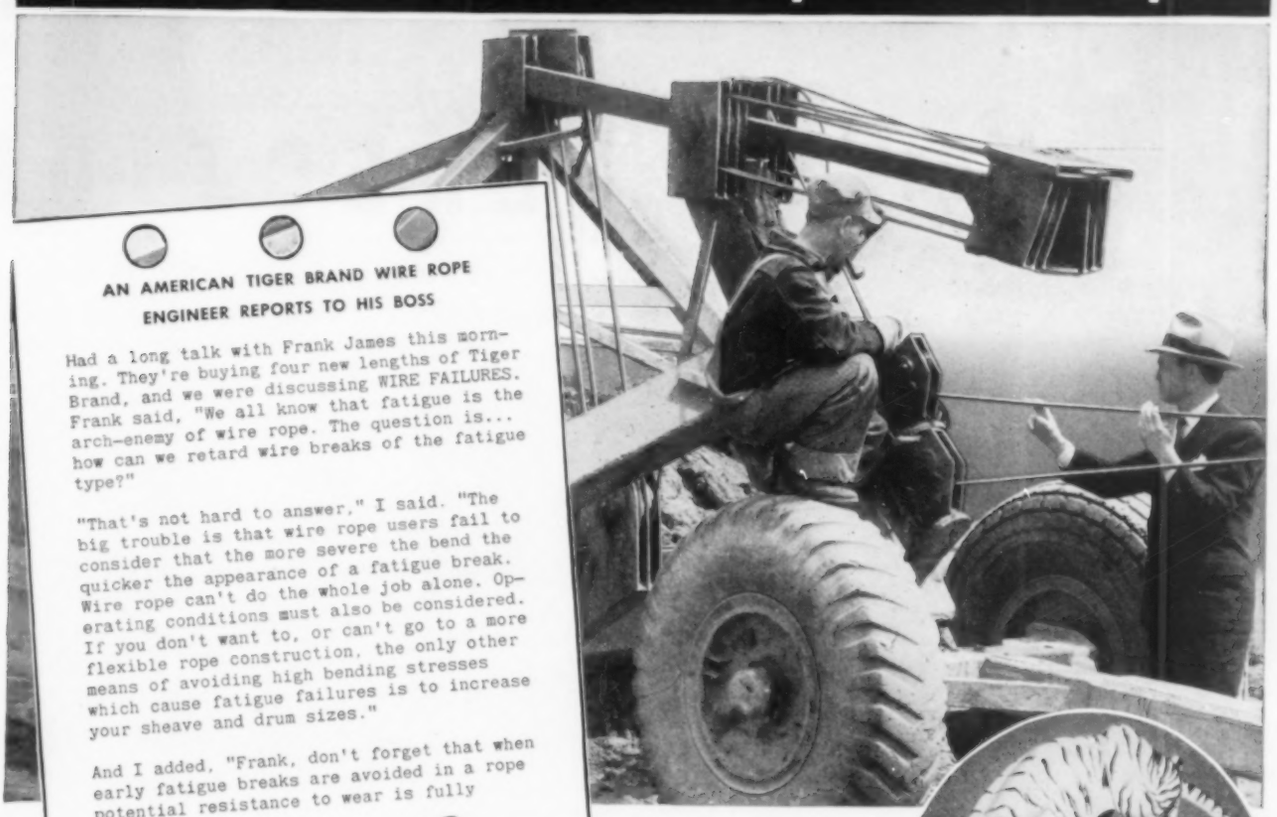
The new Hanna Cylinder Catalog No. 930 is replete with illustrations, dimensions, capacities and valuable engineering data to help you select the correct cylinder or control valve for every application. Available to executives and engineers requesting it on company letterheads. Send for your copy today.



Hanna Cylinders

AIR AND HYDRAULIC

"FATIGUE is the Arch-Enemy of Wire Rope!"



AN AMERICAN TIGER BRAND WIRE ROPE ENGINEER REPORTS TO HIS BOSS

Had a long talk with Frank James this morning. They're buying four new lengths of Tiger Brand, and we were discussing WIRE FAILURES. Frank said, "We all know that fatigue is the arch-enemy of wire rope. The question is... how can we retard wire breaks of the fatigue type?"

"That's not hard to answer," I said. "The big trouble is that wire rope users fail to consider that the more severe the bend the quicker the appearance of a fatigue break. Wire rope can't do the whole job alone. Operating conditions must also be considered. If you don't want to, or can't go to a more flexible rope construction, the only other means of avoiding high bending stresses which cause fatigue failures is to increase your sheave and drum sizes."

And I added, "Frank, don't forget that when early fatigue breaks are avoided in a rope potential resistance to wear is fully realized."

George

NUMEROUS conditions affect wire rope life, but none limits normal efficiency more than severe bending. Wire ropes are manufactured in various constructions for the purpose of securing varying degrees of flexibility. However, increased flexibility is secured at the sacrifice of resistance to abrasion, because greater flexibility is produced by increasing the number of wires in a wire rope which means that the size of the individual wires is correspondingly reduced. In order to secure satisfactory rope life it is necessary to specify a rope construction composed of wires of a large enough diameter so that they will not wear through in a comparatively short time. However, if the sheaves over which the rope operates are not of adequate size, bending stresses will be imposed which will cause wire breaks of a fatigue type and consequent removal of the rope at an early stage, even though the wear is slight. The smaller the size of sheave, the earlier these fatigue breaks will occur and the less the potential resistance to failure from abrasion will be realized.

Give these matters the attention they deserve and replacement of wire rope will be much less frequent. You'll get longer cable life.

Excellay Preformed

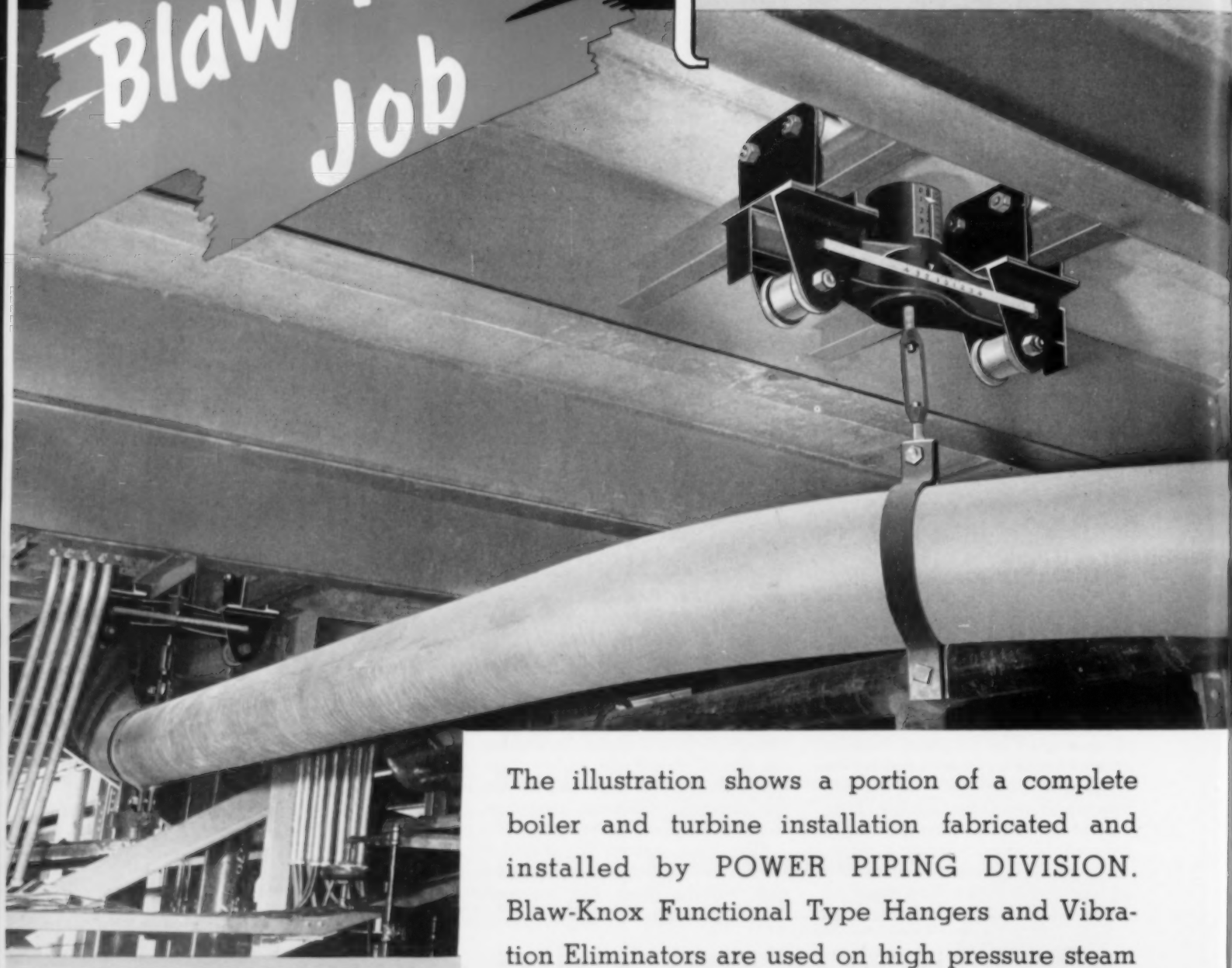
Rely on the advice of the American Tiger Brand Wire Rope Engineer. These men can make recommendations which will correct the difficulties you are encountering. They will work with you, without obligation, to help you secure a full dollar's value out of every dollar you invest in wire rope.

AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York
COLUMBIA STEEL COMPANY
San Francisco
United States Steel Export Company, New York

UNITED STATES STEEL

An "All-out" Blaw-Knox Job

PIPING — HANGERS — ERECTION



The illustration shows a portion of a complete boiler and turbine installation fabricated and installed by POWER PIPING DIVISION. Blaw-Knox Functional Type Hangers and Vibration Eliminators are used on high pressure steam and high pressure boiler feed lines. Type 7 all directional hangers are shown in the illustration.

A copy of "FLEX-ANAL CHARTS" TO ANY ENGINEER ASKING FOR IT ON HIS BUSINESS LETTERHEAD.

Send for Bulletin entitled POWER PIPING FUNCTIONAL HANGERS AND VIBRATION ELIMINATORS.

BLAW-KNOX COMPANY
POWER PIPING DIVISION
1525 PENNSYLVANIA AVE., PITTSBURGH, PA.

COMPRESSOR EQUIPMENT

STURDY • SOUNDLY DESIGNED

JARECKI VALVES

Sizes and types to meet every condition, each soundly built, perfectly threaded and individually tested.

ERIE UNLOADER

Maintains constant pressure by governing inlet of compressor. Loads and unloads without shock or strain.

ERIE GOVERNORS

For steam engines, pumps or compressors. For speed control only or for combined speed and pressure control.

JARECKI FITTINGS

Air-furnace malleable fittings . . . close-grained, cast iron fittings, all with perfect threads. A complete line.

JARECKI *Manufacturing Co.*

ERIE PENNSYLVANIA, U.S.A

Here's Why . . .

YOU CAN GIVE UP "HOME MADE" DEVICES & SAVE TIME and MONEY with RICHMOND FORM-TYING METHODS FOR CONCRETE WORK

Before the Air-Gun came along you needed a gang to get one drilldown. But not now! And, before Richmond came along you had to struggle along with "Home-Made" form-tying devices. But no longer!

Richmond gives you patented pre-fabricated form-tys specifically engineered for tying and anchoring concrete forms of every kind—from light wall construction to heavy engineering structures. You turn out a better job with Richmond. You save time with Richmond. You save money with Richmond. These are facts. Richmond will gladly lay ample proofs in your lap without cost or obligation.

RICHMOND 10-WAY PROFIT PLAN

1—Over 60 different form-tying devices meeting every condition. 2—Cost less to use than usual "Home-Made" wire, band or rod tys. 3—Engineered for safe working loads of 1500 to 25000 lbs. 4—Faster erecting and stripping saves time and lumber. 5—Promotes perfect wall alignment, plus uniform thickness. 6—1 to 2 inch "hold back" protects job against rust staining. 7—Weight scientifically cut to save shipping and handling costs. 8—Delivery right to the job saves warehousing. Job section labels save time. 9—No cost for working parts. You pay only for tys used. 10—Job planning bureau specifies types, quantities, methods, free.

WORKING PARTS LOANED!

Get Point 9. Why pay for stuff you don't need. Buy your tys only. Return working parts for full credit. This, by itself is worth plenty.

11 pages of buying data for Architects, Engineers, Builders, Contractors.

SEE OUR CATALOG IN SWEET'S

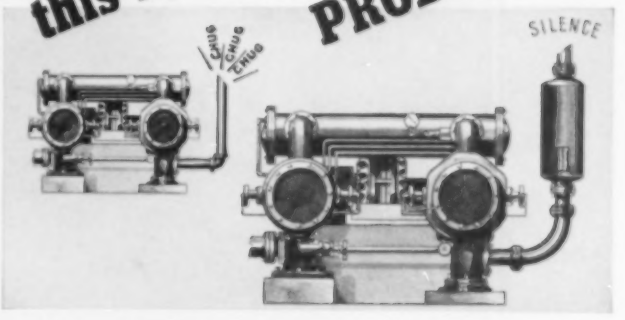
RICHMOND SCREW ANCHOR COMPANY, INC.

816 LIBERTY AVENUE, BROOKLYN, N. Y.

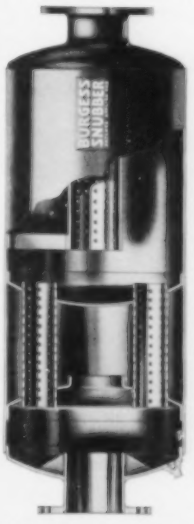
When Compressor Intakes Are Noisy

DECREASE this NOISE

INCREASE PRODUCTION



SNUBBING Quiets Compressor Intakes without "Choking"—



Sectional view of Burgess SDI Intake Snubber, showing paths for free flow of air.

Does compressor intake noise create a nerve-racking distraction in your plant? If so, install a Burgess Intake Snubber and this troublesome noise will completely disappear. Your men will have a quieter place in which to work, which usually improves their productive efficiency.

Pumping noise in compressor intakes is due to the rapid pressure pulsations in the intake piping. A Burgess SDI Intake Snubber in the intake line snubs these pulsations and smooths the flow of air to a quiet stream.

The snubbing principle was originated by Burgess. The construction of the Burgess Intake Snubber limits pulsations without impairing the free flow of air. Therefore, the efficiency of the compressor is not lowered.

If you have a noisy compressor intake or vacuum pump discharge, let us recommend a Burgess Intake Snubber to prevent such noise and improve working conditions in your plant.

Burgess Battery Company, Acoustic Division
510 W. Huron St., Chicago, Ill.

Originators of Snubbing Principle for Quieting Diesel Exhausts
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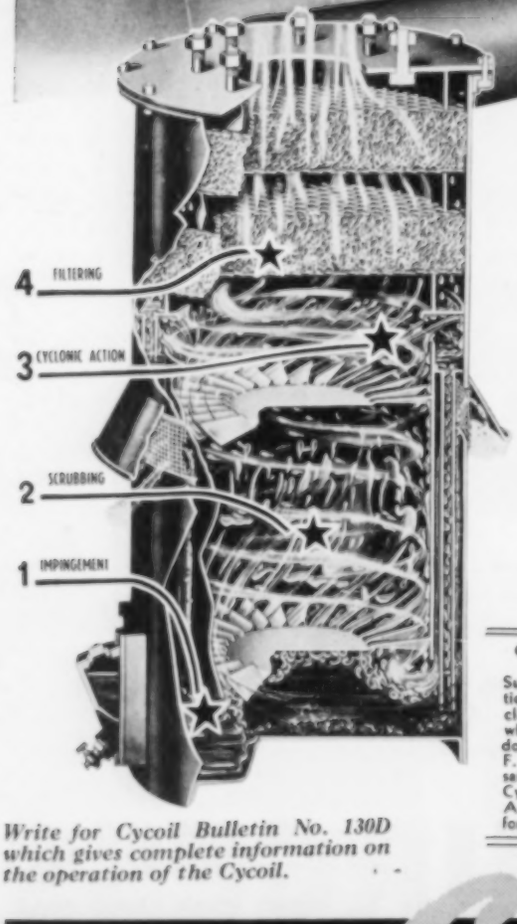
BURGESS SNUBBERS

Don't Overlook the Importance of the RIGHT AIR FILTERS!

OK with Cycoil Cleaners



Write for Cycoil Bulletin No. 130D which gives complete information on the operation of the Cycoil.

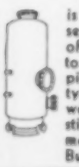
All engine manufacturers know the Cycoil and its many advantages, and they will gladly equip your new engines with Cycoils—IF YOU SPECIFY THEM.

Frankly, Cycoil air cleaners will cost you slightly more than ordinary filters, but in dollar outlay, air cleaners are still a small factor in any engine set up. The job they do and the money they save when properly engineered to give maximum protection IS A BIG FACTOR, however, which no user of engines can afford to overlook.

Through uninterrupted service under the most exacting conditions in the dust bowl areas and in the southwest oil fields, Cycoil filters have proved their superiority. Complete information on all American Air Filters for engine and compressor protection is available without obligation. Please write us for bulletins.

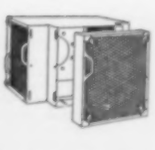
AMERICAN AIR FILTER CO., INC.
Incorporated
202 Central Avenue, Louisville, Kentucky

CYCOIL GAS CLEANER
Suitable for practically every gas cleaning problem when temperatures do not exceed 140° F. Operates on same principle as Cycoil Oil Bath Air Cleaner. Ask for Bulletin 130D.



PL-H FILTER
is a complete assembly consisting of housing, ready to bolt to intake pipe, and dry cell type filters in which wool felt constitutes the filter medium. Ask for Bulletin 120D.

TYPE OC FILTER
Complete assembly consisting of washable viscous impingement type filters. 1, 2, 3, or more cells are used depending upon size of cleaning job. Ask for Bulletin 120D.



AMERICAN *Cycoil* AIR and GAS CLEANERS

A New JACKHAMER

The 45 lb. Class JB-4

AN EASY-HOLDING DRILL

● The JB-4 Jackhamer, is a lightweight, fast drilling machine, ideal for general excavating and for contract, quarry, and mining work. Its low air consumption makes it especially desirable for use with portable air compressors—also wherever air is at a premium.

New features include an enclosed throttle valve indent, a new drop-forged blower valve handle, and a new, easy-opening steel holder.

The new steel holder reduces the time required for changing steels. You don't have to stoop to operate it — merely push down on the lever with your foot and the steel drops out.

Easy handling resulting from an improved distribution of weight—plus high drilling speed—plus the features mentioned above—make the JB-4 a great favorite.

5-57

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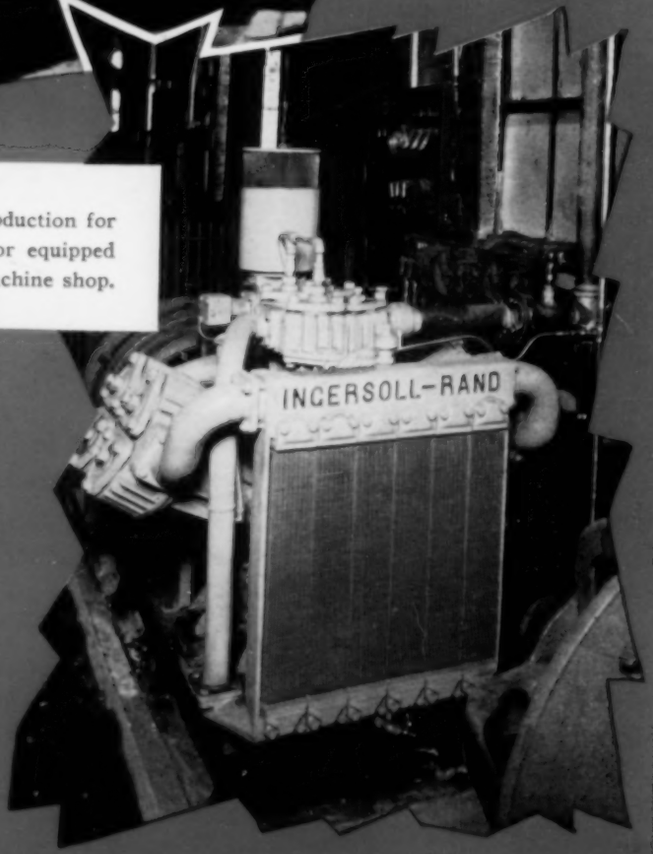
TIMKEN Bearings are used in all kinds of American Defense Armament—And in the Machines that make it . . . .

One of the Army's new mobile forts—a 28-ton tank. This is one of the most heavily armed combat vehicles in the world. Like all kinds of American mechanized defense armament, this tank is equipped with Timken Bearings.

PHOTO BY U. S. ARMY SIGNAL CORPS.



Compressed air is an important factor in production for defense. Here is a 40 H.P. Motorcompressor equipped with Timken Bearings installed in a large machine shop.

You should have Timken Bearings in your machines (no matter what kind) for the same reason that the U. S. Army has them in its guns, tanks, armored cars, trucks, airplanes and other defense equipment . . . for speed, accuracy, dependability and endurance.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

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